LIBRARY
JUL 1 1946

June, 1946

EDISON ELECTRIC INSTITUTE BULLETIN

The Institute's Annual Meeting 177
The President's Address . . . . . C. W. KELLOGG 183
Progress of Rural Electrification in United States . G. C. NEFF 187
Kellogg's Retirement Terminates Distinguished Career in Electric Industry 190
The Utility Industry's Interest in the Establishment and Growth of Small Industries . THOMAS N. McCARTER, JR. 191
A Factual Analysis of the TVA . . . . . HUET MASSUE 193
Public Benefits Through Using Existing Facilities for Marketing Power from Government Dams RALPH L. CARR 195
Developments in Rural Telephone Service of Interest to Electric Utilities . . . . . A. E. SILVER 199
A Utility Man Looks at Atomic Energy . DR. J. C. PARKER 205
Basic Ideas Underlying the Utilization of Atomic Energy for Power Production . . DR. KENNETH H. KINGDON 209
Nuclear Research in General Electric . . DR. C. G. SUITS 213
Some Engineering and Political Aspects of Atomic Energy HARRY A. WINNE 217
Personals 222
Conventions and Meetings 224

PUBLISHED MONTHLY BY EDISON ELECTRIC INSTITUTE

THE ELECTRIC LIGHT AND POWER INDUSTRY

Current Statistical Data Covering 100 Per Cent of Industry

March, 1945-1946

SOURCE AND DISPOSAL OF ENERGY (In Kilowatthours)—MONTH OF MARCH

	1946	1945	%
GENERATION* (Net)			
By Fuel Burning Plants	10,517,207,000	12,046,872,000	−12.7
By Water Power Plants	7,271,182,000	7,479,258,000	− 2.8
Total Generation	**17,788,389,000**	**19,526,130,000**	**− 8.9**
Add—Net Imports Over International Boundaries	158,516,000	147,514,000	+ 7.5
Less—Company Use	132,041,000	127,149,000	+ 3.8
Less—Energy Used by Producer	165,203,000	76,329,000	.....
Net Energy for Distribution	**17,649,661,000**	**19,470,166,000**	**− 9.4**
Losses and Unaccounted for	2,559,145,000	2,594,358,000	− 1.4
Sales to Ultimate Customers	**15,090,516,000**	**16,875,808,000**	**−10.6**

CLASSIFICATION OF SALES

NUMBER OF CUSTOMERS—As of March 31st			
Residential or Domestic	28,499,536	27,595,843	+ 3.3
Rural (Distinct Rural Rates)	1,253,581	1,151,605	+ 8.9
Commercial or Industrial:			
Small Light and Power	4,471,834	4,266,892	+ 4.9
Large Light and Power	165,719	152,263	
Other Customers	118,981	118,294	.....
Total Ultimate Customers	**34,509,651**	**33,284,897**	**+ 3.7**
KILOWATTHOUR SALES—During Month of March			
Residential or Domestic	3,282,094,000	2,889,220,000	+13.6
Rural (Distinct Rural Rates)	249,320,000	192,951,000	+29.2
Commercial or Industrial:			
Small Light and Power	2,622,336,000	2,501,591,000	+ 4.8
Large Light and Power	7,592,054,000	9,717,094,000	−21.9
Street and Highway Lighting	192,955,000	187,447,000	+ 2.9
Other Public Authorities	486,015,000	691,010,000	−29.7
Railways and Railroads:			
Street and Interurban Railways	384,195,000	411,561,000	− 6.6
Electrified Steam Railroads	228,616,000	229,165,000	− 0.2
Interdepartmental	52,931,000	55,769,000	− 5.1
Total to Ultimate Customers	**15,090,516,000**	**16,875,808,000**	**−10.6**
Revenue from Ultimate Customers	**$282,543,400**	**$280,812,300**	**+ 0.6**

RESIDENTIAL OR DOMESTIC SERVICE

AVERAGE CUSTOMER DATA—for 12 months ended March 31, 1946			
Kilowatthours per Customer	1.267	1.172	+ 8.1
Average Annual Bill	$42.57	$40.90	+ 4.1
Revenue per Kilowatthour	3.36¢	3.49¢	− 3.7

(*) By courtesy of the Federal Power Commission.

Vol. 14, No. 6, EDISON ELECTRIC INSTITUTE BULLETIN; published monthly. Entered as second-class matter Aug. 17, 1933, at the post office at Philadelphia, Pa., under the act of March 3, 1879. Publication office, 56th and Chestnut Sts., Philadelphia, Pa. Editorial office, 420 Lexington Ave., New York, N. Y. Subscription rate $2.00 per year in the United States; $3.00 per year in foreign countries.

The Edison Electric Institute does not assume responsibility for, nor necessarily endorse or approve, statements made by contributors to the BULLETIN.

EDISON ELECTRIC INSTITUTE BULLETIN

Volume 14 JUNE, 1946 No. 6

The Institute's Annual Meeting

Largest Attendance Since 1941—Confidence and Aggressive Planning for Future Activities Reflected

THE retirement of C. W. Kellogg as President of the Edison Electric Institute, and the election of Grover C. Neff, President of Wisconsin Power and Light Company, to succeed Mr. Kellogg, an exceptionally timely program replete with important topics, capably handled by outstanding speakers, and a universal feeling among those attending of confidence and aggressive planning for future action, marked the Institute's annual meeting, which was held at the Waldorf-Astoria Hotel, New York City, through June 3-5, inc.

The annual meeting attracted the largest attendance, approximately 1000, of any Edison Electric Institute meeting since 1941. A total of 25 addresses, covering a wide range of subjects of immediate importance to the industry, were delivered during the six general sessions. A number of the addresses, including the four on atomic energy, appear in this issue of the BULLETIN, and others will be published in forthcoming issues.

In addition to the election of Mr. Neff as President, P. H. McCance, President of the Duquesne Light Company, Pittsburgh, was elected Vice-President and K. B. Crumb, American Gas and Electric Company, was elected Treasurer of the Institute. Colonel Howard S. Bennion was re-elected Vice-President and Managing Director and Miss Mae B. Woods re-elected Secretary.

New Directors of the Institute elected were J. E. Loiseau, President of Public Service Co. of Colorado, Denver; A. H. Kehoe, Vice-President of Consolidated Edison Company of New York; J. R. Whiting, President of the Commonwealth and Southern Corp., New York; E. L. Lindseth, President of Cleveland Electric Illuminating Company, Cleveland, and C. E. Michel, Vice-President of the Union Electric Company of Missouri. Other directors whose terms expired currently were re-elected to fill terms expiring in 1948 and 1949.

Mr. Neff, who has been President of the Wisconsin company since 1933, brings to his new position long and varied experience in utility management. Widely known throughout the industry for his interest in farm electrification, and his success in carrying out programs for extension of service to farmers, Mr. Neff's record fully qualifies him to assume the duties of his new post.

With his election, the Institute returns to its former policy of a part-time, non-salaried President, who will be elected annually.

First General Session

Mr. Kellogg opened the meeting with the President's Address. Reviewing the war years, he pointed out that "at no time was any part of the war program delayed or hindered by lack of electric power, while, at the same time, full service was maintained to all customers, military and civilian. All further discussion of a 'power shortage' has ceased."

The amount received by the electric companies for power sold by them for war purposes only was $2,350,000,000, Mr. Kellogg said, pointing out that during the war years, the industry had paid almost the same amount, or $2,194,000,000 to the Federal Government in direct taxes.

Despite hourly pay increases in the industry of about 30 per cent during the war, unit fuel cost advances of 32 per cent, and tax increases of 24 per cent, the average unit price of residence electricity declined by 11 per cent from 1940 to 1945, and that of commercial and industrial power by 10 per cent and 12 per cent respectively, he stated.

Governmental power enterprises reveal "a deliberate intent to overwhelm and destroy our business," Mr. Kellogg charged, urging the most constant vigilance of operating officials "to protect our companies from further government raids."

A. E. Silver, of Ebasco Services, Inc., New York City, followed Mr. Kellogg with a discussion of the latest developments in rural telephone service. The rapid extension of power and telephone services to the now unserved farms, with sound economic outcome, calls for physical facilities and their operation with the maximum of overall economy, Mr. Silver said, adding that the power and telephone companies are working towards the best overall engineering solution.

The trial installtions of carrier telephone service so far have given satisfactory service and valuable experience is being secured in its operation and maintenance, Mr. Silver remarked. Frequent cases have been found where its use promises economic advantage, and development work is being continued for further simplification, reliability and economy.

R. L. White, President of Landers, Frary & Clark, New Britain, Conn., and also President of the National Electrical Manufacturers Association, said that "the utility companies deserve applause from the manufacturers for their fine job of servicing appliances, particu-

OFFICERS
OF THE INSTITUTE
1945-1946

GROVER C. NEFF, *President*

P. H. MCCANCE, *Vice-President*

H. S. BENNION, *Vice-President and Managing Director*

K. B. CRUMB, *Treasurer*

MAE B. WOODS, *Secretary*

GROVER C. NEFF

Newly Elected President, Edison Electric Institute

larly during difficult conditions." The utility that does not wish to service appliances itself can operate service training programs, teaching young men to be repair men, and can also, through its home service personnel, help the consumer to use his electrical equipment properly, he suggested.

The utility company's ability to carry out its responsibilities to its customers and employees will depend more and more upon increasing its output, by adding a greater volume of profitable business, G. W. Ousler, Vice President, Duquesne Light Company, Pittsburgh, Pa., told the meeting. Intensive sales effort will be required, he emphasized, stating that every business in the country is going to make a determined effort to get as big a share of the customer's dollar as possible, through intensive sales and advertising programs.

Severe competition will be found in every utility market, Mr. Ousler said, adding that the EEI Commercial Division will develop load-building activities on a national basis, of a scope that cannot be economically developed on the local company level. The new EEI Sales Training Course, which cost $140,000 to produce, was cited as an example. Purchases of the course already amount to about $120,000, Mr. Ousler said.

The work of the 22 organizational committees of the EEI Commercial Division has been planned to cover all the desirable phases of promotional effort, and is especially well designed to conform with the transitional period through which we are now passing, James T. Coatsworth, Commercial Director of EEI, said, in a brief description of his department's work. "The Committee work succeeds in ratio to the calibre of men you allow to represent you on them," he told the audience, urging that the best utility personnel available be allowed to participate in the work of the committees.

Atomic Energy Symposium

A glimpse into some of the problems that must be solved before atomic energy can be successfully harnessed, and a description of plans now being made to put this new power source to work, was presented to the meeting on Monday afternoon, in the second general session.

Dr. Kenneth H. Kingdon, in charge of nuclear research of the General Electric Company's Research Laboratory, gave the audience a graphic presentation of the fundamental physics involved in the operation of the uranium power pile, the structure in which the uranium atom is split, and its tremendous energy released. If all the atoms in one pound of U^{235} could be freed, the total energy made available would be 11 million kilowatthours, he said.

"In all cases, it appears that the energy must be recovered as heat for useful purposes, and practically none can be converted directly into electricity," Dr. Kingdon declared.

Six illustrations of proposed power systems, designed to use atomic energy, were shown to the meeting by Harry A. Winne, Engineering Vice President of General Electric. Each system poses difficult problems for the engineer, he stated, mentioning that many phases of heat transfer, and the structural engineering and mechanical design of all elements of the power pile, require much research and development work.

Three distinct and seemingly permanent limitations, controlling not only the design but also the field of application of atomic power plants, are the necessity for shielding the neutron and gamma radiation, the high cost of fuel, and health hazards, Mr. Winne said.

"It is evidently impossible to make an accurate analysis of the economics of atomic fuel, on the basis of information generally available today," he declared.

Electrical manufacturing companies, with their long experience and impressive technology in power production,

GROVER C. NEFF

GROVER C. NEFF, President of Wisconsin Power and Light Company, Madison, Wis., was elected President of the Edison Electric Institute by the Board of Directors at the annual meeting. Mr. Neff succeeds C. W. Kellogg, who has reached the retirement age.

Mr. Neff has already assumed his new position, and he will serve for one year. With his election, the Institute returns to its former policy of having a non-salaried President, who will be elected annually from among member company executives.

Born on a farm near Milford, Ind., in 1886, Mr. Neff was graduated from Purdue University in 1907, with a degree in engineering. He joined American Bridge Company, and entered the utility business in 1908, as a resident engineer on construction work in Wisconsin.

In 1910 he became superintendent of Southern Wisconsin Power Company. Between 1914 and 1922, he was the General Superintendent of Southern Wisconsin Power Company, Wisconsin River Power Company, Wisconsin Power, Light & Heat Company, Mineral Point Public Service Company, Janesville Electric Company and Eastern Wisconsin Electric Company.

These companies were merged into the Wisconsin Power and Light Company in 1924 and Mr. Neff was elected Vice-President in charge of operations for that company.

In 1932 he was called to Chicago by the receivers of Middle West Utilities Company, where he spent a year dealing with operating problems of Middle West subsidiaries.

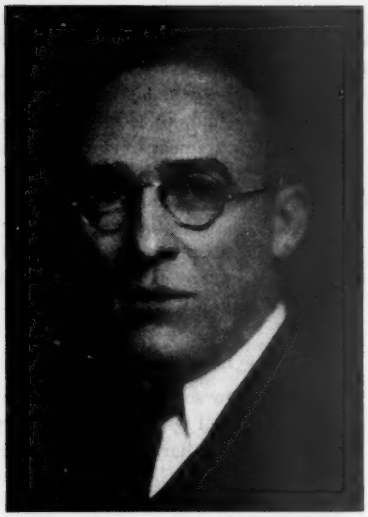
He returned to Wisconsin Power and Light Company as President in 1933.

Mr. Neff has been active in association work, serving as Chairman of the Rural Electric Service Committee of the National Electric Light Association from 1922 to 1927, and as Secretary and Treasurer of the Committee on the Relation of Electricity to Agriculture from 1923 to 1939.

He is also a past president of the Wisconsin Utilities Association, and a past Chairman of the Madison, Wisconsin section of the American Institute of Electrical Engineers.

Throughout his career in the utility industry, he has been a strong advocate of extending electric service to farmers.

He married Miss May Prehn of Portage, Wis., in 1910 and has two children William James of Kansas City, Kans., and Mary Louise (Mrs. W. M. Beeson) of Lafayette, Ind.



P. H. McCANCE

New Vice-President

Mr. McCance joined the Philadelphia Co. in 1923, as an attorney. Personnel director from 1929 to 1938, he then became vice president of Philadelphia Co., and senior vice president, Duquesne Light and Equitable Gas Companies, in 1940. He was elected president, Duquesne Light Co., in 1942.

will take a leading part in the atomic power problem, the meeting was told by Dr. C. G. Suits, of the General Electric Company. Atomic energy has exerted more influence on the planning of research in his company than any other single factor, he added.

A complete re-examination of the problems of power production, in the light of new possibilities presented by the atom, has led to a realization of the scope of the problems of atomic power plant development, placed a tentative time scale on the project, and has consequently indicated the scale of the research and engineering effort required for the job, he announced. His organization has laid out a long-range program of nuclear research, to explore new types of nuclear reactions, and to investigate nuclear fission for its power production possibilities.

Only by cooperation between the government and the electric utility industry can atomic energy be speedily and fully developed for the public benefit, Dr. John C. Parker, Vice President, Consolidated Edison Company of New York, declared. In the past the utility industry not only has met, but has welcomed and actively stimulated improvements in the power arts, and could be expected to explore vigorously any possibilities offered by the atom.

Restrictions on important technical information were cited as a primary difficulty retarding the industry by Dr. Parker, who said that a second impediment is the tacit assumption that necessarily permission to use or produce fissionable materials must be restricted.

"It is important," he said, "that at the earliest possible date a program be established for the freer discussion of all knowledge that is available in this new field. This is not a matter of interest to the public utilities alone, or even primarily to the public utilities. Despite certain practical necessities in some areas and at some times, secrecy is fundamentally abhorrent in our social and economic relations. It is particularly dangerous when the secrets are entrusted to a relatively small group within a government."

As to the possibilities of atomic power bringing tremendous operating economies to electric systems, Dr. Parker asserted, "Nothing that has been said to date indicates that we may look for systems of transmission and distribution arising from atomic power plants, as such, different from what we have today. The bulk of the investment of human labor and of materials which makes the capital structure of our electric systems is found precisely here. Atomic energy then cannot be expected to bring about any saving in the dominant element of electric power systems."

Third General Session

Frank Sanford, Western Editor of *Electric World,* opened the Tuesday morning session with an address on "Planning Distribution Facilities for Increased Customer Use."

The present distribution system in most companies contains a certain amount of inherent capacity for increased loads, which can be utilized by skilful planning and judicious rearrangement and amplification of distribution system plant, Mr. Sanford declared. Transformers, for example, are able to withstand greater loads, secondaries are generally adequate if of approximately No. 2 AWG copper size, primaries can be rearranged for greater load carrying ability, yet with greater reliability, it was pointed out.

The danger is, Mr. Sanford explained, that most additions to the distribution system are small and infrequent, and the need for long-range and accurate planning is not as immediately apparent as in other parts of the electric system.

K. B. CRUMB

New Treasurer

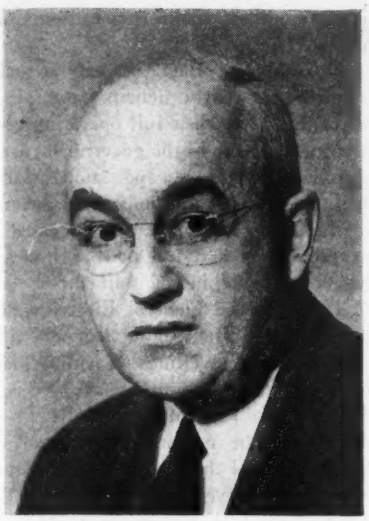
Mr. Crumb has been with American Gas & Electric Co. and its subsidiaries since 1909. Following positions with subsidiary companies in Rockford, Ill., and Newark, Ohio, he joined the New York office in 1911 as a traveling auditor. He was appointed Treasurer of the Company in November, 1944.

A brief discussion of Mr. Sanford's paper was led by J. H. Foote, Supervising Engineer, The Commonwealth & Southern Corporation, who said that "Increased customer loads of tomorrow will involve the sale of large amounts of current at a very low price. It will be necessary that the skill and coordination of the entire organization be directed toward the serving of these increased loads in the most economical manner possible."

The soft coal industry has embarked upon a $2,500,000, five-year research program, with another $1,000,000 invested solely for locomotive development, the meeting was told by J. E. Tobey, of Bituminous Coal Research, Inc., cooperative research organization of the industry. Revolutionary coal-burning equipment, ranging from household appliances to gas turbine locomotives, is under development in the laboratories.

The research program has also served to unite the industry perhaps more than any single activity, Mr. Tobey continued, and has given its employees the feeling that they are part of a progressive industry. Sponsors of the program are convinced from the record of Bituminous Coal Research, that industry research can pay its own way.

The Hon. Ralph L. Carr, former



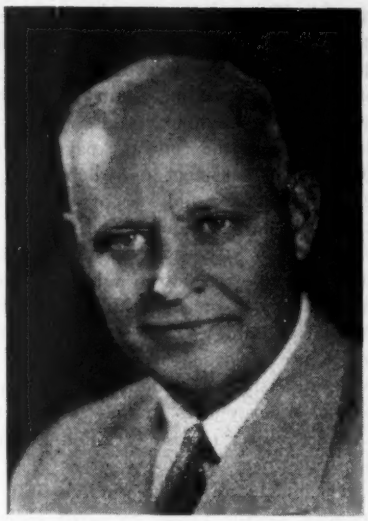
A. H. KEHOE
New Director

Starting as engineering assistant with the Consolidated Edison System in 1911, Mr. Kehoe has been the superintendent, T & D department, and electrical engineer. He became vice president, New York Edison Co., in 1932, and was elected vice president, Consolidated Edison Co., in 1936.

Governor of Colorado, said that "The mere building of government dams and the installation of power generating facilities, while serious, in themselves should not constitute a threat to the stability of the electric utility industry. However, the policies and methods for marketing the power, which are still in a tentative and formative stage, may drastically affect the industry throughout the whole country."

If the government dams are to be operated largely independently, he explained, with separate transmission systems and separate markets, additional facilities must be installed to supplement the hydro in dry seasons. Such additional facilities will not be needed in periods of good river flow, and will represent a direct duplication of investment in generating facilities. "This is definitely a wasteful duplication, which could be avoided by pooling the Government hydro plants with existing plants," he charged, adding that "A further saving would arise from avoidance of transmission facilities for connecting the Government steam plants."

All Government agencies having jurisdiction should take the lead in bringing together the utilities, municipal power systems, state power systems and the REA into a fully cooperative program, so as to assure full and effective utilization of the power developed to avoid duplication and waste, provide adequate facilities, reduce power costs, and encourage increased power use, Mr. Carr urged.



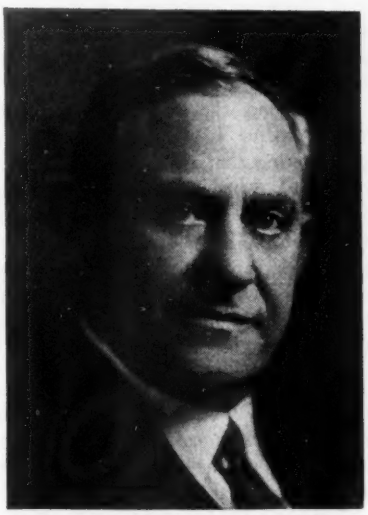
ELMER L. LINDSETH
New Director

Mr. Lindseth has spent his entire working career with The Cleveland Electric Illuminating Co., starting in 1924 as a test helper. He has been production engineer, vice president in charge of sales, and executive vice president. He became president of the Cleveland company in 1945.

"The health and growth of industry in any utility territory is vital to any expansion and future growth of residential and commercial communities, and the resultant electric revenue derived there-

JOHN E. LOISEAU
New Director

Mr. Loiseau joined the utility company in Mt. Vernon, Ill., in 1915, as chief accountant. He then served with utility companies in Mansfield, Ohio, and Montgomery, Ala. He became secretary of the Public Service Co. of Colorado in 1922, and was elected president of that company in 1943.



CHARLES E. MICHEL
New Director

Originally employed by the Union Electric Co. of Missouri in 1907, as manager of the company's automobile department, Mr. Michel became sales manager in 1918, and sales vice-president in 1935. He assumed executive management duties in 1946, retaining his title of vice-president.

JUSTIN R. WHITING
New Director

Mr. Whiting became a member of the law firm of Weadock and Whiting, general counsel for The Commonwealth & Southern Corp., in 1933. He had previously been associated with several law firms in Michigan. He became president of The Commonwealth & Southern Corp. in 1940.

from," Thomas N. McCarter, Executive Vice President, Public Service Corporation of New Jersey, Newark, N. J., declared. Expanding industrial firms will draw new employees into a particular area, and the company payroll will be used to construct new homes, purchase appliances and support stores in the surrounding neighborhood.

Industrial sales stability of the electric company depends to a large degree on the growth of small industries, Mr. McCarter said. "Local markets will often provide adequate support for a wide diversity of products and small plants. Energy sales to these customers will be subject to less variation during depression periods."

Technical and engineering assistance supplied by the utility to small industrial companies should be a basic approach to sales of new uses of electricity, he remarked. "With much of small industry handicapped by lack of materials, pricing regulations and some labor problems, these industries are going to need help if they are to survive and grow," Mr. McCarter said.

Fourth General Session

In a review of the advertising and public relations accomplishments of the campaign conducted by a group of more than 160 business-managed utilities, P. H. McCance, President of Duquesne Light Company, Pittsburgh, Pa., said that a greater proportion of the public now believes that private ownership of utilities is more efficient than government ownership, than was the case two years ago.

Opinion research studies in 1943 revealed that 41 per cent of the public favored private ownership of utilities, and 52 per cent favored government ownership. Similar studies in 1945 showed that 51 per cent favored private ownership, against 42 per cent in favor of government ownership.

The industry is now advertising in 2,976 newspapers, with total circulation of 20,526,000; in national magazines with a circulation of 19,400,000, and on the air with a network program that reaches an estimated 5,790,000 listeners each week.

The theme of the program will shortly shift to a clarification of the companies' position with regard to the invasion of the electric service field by the government, Mr. McCance said.

Rising costs in materials and labor can be offset by industry with a $239,000,000 investment in seven modern electrical techniques, C. B. Stainback, Manager of the industrial department of Westinghouse Electric Corporation, told the meeting. He itemized these improvements as follows: $90,000,000 for new wiring in factories; $65,000,000 for lighting fixtures; $25,000,000 for air cleaning and air conditioning; $20,000,000 for radio frequency heating, and $39,000,000 for resistance welding equipment, furnace brazing equipment and infra-red heating. He said that the investment would increase by 27 per cent the amount of horsepower at the command of each worker over the amount at his disposal during the height of war production.

The Westinghouse presentation, in which Mr. Stainback was assisted by J. M. McKibbin, assistant to the vice president of Westinghouse, featured models of industrial plant equipment, film slides, etc., and is entitled "Productive Power." The show will soon tour the country, and will be exhibited to industrial executives and engineers in major cities, as an aid to utility power sales departments.

Fifth General Session

A cost analysis picturing the Tennessee Valley Authority as a wholly uneconomical project, and a failure on all counts, when its cost is measured against that of like achievements by private enterprise, was presented to start the final day's sessions by Huet Massue, consulting engineer of Montreal, Canada.

Discussing the results of a careful study of the TVA, Mr. Massue told the meeting that the "real capital cost" of the TVA had amounted to more than $1,000,000,000, as against a reported figure of $778,000,000. This total, he said, took into account the whole cost of Wilson Dam, losses of taxes and interst not paid on the government's investment in the Authority.

Even exclusive of interest and tax factors, TVA's power developments were built at a cost altogether out of proportion to the cost of other hydro plants, Mr. Massue charged.

Fifteen TVA power installations brought a greater expenditure on a unit-cost basis than all but one of eight privately owned hydro-electric plants in the U. S., he said. He put the expense of the TVA "Kentucky" development, as an example, at more than eight times that of the Duke Power Company development, and more than six times that of the Southern California Edison Company.

Operation of the Authority actually resulted in yearly deficits from 1938 through 1945, when full operating costs and interest cost to the government were considered, Mr. Massue said. Manufacturing activity and individual incomes in the TVA area have not increased as expected, as a result of the low-cost power available, he maintained.

The Portland General Electric Company has at present more than 700 electrically heated dwellings on its lines, and from 30 to 40 inquiries are received daily, J. H. Polhemus, company President, told the meeting. His company has approached the electric house heating problem with eyes fully open to the difficulties which characteristics of this type of load might pose.

Seventy-five test dwellings were selected in September, 1945, and a thorough analysis of the heating load over a full 12-month period was begun. The objectives were to determine load and diversity characteristics, power costs and distribution costs. From primary data obtained, the company will be able to derive a new house heating rate, Mr. Polhemus said, that will cover all costs of service to this load plus a reasonable return.

An aggressive and pioneering approach to business development problems such as electric house heating has paid off, not only in operating profits, but also in expanded services and benefits for customers at lower unit costs, and in improved public relations, he remarked.

A large potential market for electric house heating exists in the Southeast, J. M. Barry, Vice President of the Alabama Power Company, Birmingham, Ala., said. But in his company's area, house heating with resistance units is generally not competitive with other fuels. "The only way to make electric house heating practical in our area is to develop the heat pump to improve its coefficient of performance, and otherwise perfect it for the dual job of summer cooling and winter heating, and to make its application economically feasible," Mr. Barry said.

Much research remains to be done to determine the economics of this appliance both from the utility and customer standpoints, he explained.

Over 100 utilities are putting the "More Power to America" program to work in their communities, and results

(*Continued on page* 186)

The President's Address

By C. W. Kellogg
President, Edison Electric Institute

Address before the Annual Meeting of the Edison Electric Institute, New York, N. Y., June 3, 1946.

IT IS difficult to realize that our 1945 Convention had to be given up on account of war travel restrictions; but V-J Day was less than a year ago. It is worthwhile to pause a moment to comment on those momentous five years, 1941 to 1945, both inclusive. The final result of the war was a victory for the industrial strength of America, powered by electricity and organized under a system of free enterprise—a demonstration of the might of a free people over the planned economy of totalitarian states, despotically controlling every act of the individual.

During those five war years over a trillion kilowatthours of electric energy were generated in this country (83 per cent of it by the electric companies and 12 per cent by the Federal Government). At no time was any part of the war program delayed or hindered by lack of electric power, while, at the same time, full service was maintained to all customers, military and civilian. All further discussion of a "power shortage" has ceased. Nor was this the only contribution of our industry. We have computed that the amount received by the electric companies for power sold by them, for war purposes only, was $2,350,000,000. These same companies during the same period paid almost the same amount, or $2,194,000,000, to the Federal Government in direct taxes.

It is well known that all things entering into public utility operation cost more at the end of the war than when it began. The hourly pay in the electric utility industry rose about 30 per cent during these years. Unit fuel cost advanced 32 per cent, and taxes, on a comparable basis, 24 per cent. In sharp contrast to this, the average unit price of residence electricity declined by 11 per cent from 1940 to 1945; of commercial electricity it declined by 10 per cent, and of industrial power by 12 per cent.

Statistical Summary for 1945

Electric energy output for a consecutive twelve-month period reached a peak in the month before V-J Day of 229,300,000,000 kilowatthours. Since that time its decline of only 8.7 per cent on a twelve-month basis seems remarkably small, in view of the drastic cancellation of orders for war supplies which began last summer. Industrial power declined of course more than this, but that decline was largely offset by substantial gains in residential and rural consumption and a slight gain in commercial use.

In spite of constant difficulty throughout 1945 in obtaining labor and materials for construction, nearly a million more electric customers (over a quarter of them farm customers) were added during the year, bringing the total at December 31 to 34,000,000. There was also an almost complete stoppage of the manufacture of electric appliances during the year, in spite of which average annual household consumption has now reached a new high of 1275 kilowatthours—a gain of nearly 11 per cent in eighteen months.

Financially, the business-managed electric utilities in 1945 passed the three billion dollar mark in gross revenues, a gain of $864,000,000 since 1939. This entire gain was taken up by greater expenses and taxes, the gross corporate income having decreased 1.7 per cent in the period and the balance for dividends having decreased about 1 per cent. It shows at least that all possible increase in net earnings arising from war operations was completely diverted into the U. S. Treasury, which should fully dispose of any claim, if such there be, that the electric utilities had profiteered from the war.

For the twelve months ending June 1946 (partly estimated) the net corporate income shows a gain over 1945 of about $55,000,000. This is partly accounted for by the elimination since January 1st this year, of the excess profits tax. Lest this should appear to be a reason for general rate reduction at this time, it should be borne in mind that increases in wages and fuel costs are likely to amount to about $100,000,000 in the twelve months now beginning.

The foregoing are but brief excerpts from the Institute's Statistical Bulletin No. 13, for 1945, which, with improved form, will be out shortly after the Convention. It is a veritable statistical bible for electric utility men throughout the year.

Institute Activities

The last two years have witnessed some increase in the scope of Institute activities. An Accounting Director, Mr. Harry C. Hasbrouck, has been appointed, and a Rural Service Manager, Mr. Roy W. Godley, has also been appointed.

The new Retirement Income Plan was inaugurated by the Institute on July 1, 1945 and under its age provisions Messrs. Greenwood, Kellogg and Maxwell retire as of July 1, 1946. Mr. Greenwood has been succeeded by Mr. James T. Coatsworth and Mr. Maxwell is being succeeded by Mr. Harry E. Kent.

The group annual meetings this spring on Accounting (jointly with the American Gas Association) in Cincinnati and the Sales Conference in Chicago both brought out record attendance. The Engineering Conference was likewise well attended.

Last year the Institute employed N. W. Ayer & Son, Inc., to conduct publicity work, but since January 1st this activity has been taken over by the National Association of Electric Companies. This change was made because of the feeling that a considerable amount of the publicity material, in order to be effective, necessarily got into controversial territory, which the Institute for the best interests of the industry, should avoid. The Institute has, however, continued, as in the past, to issue current factual data and has been the source of factual information for both the National Association and the Advertising Group.

Last year the Institute took up the subscription for its members to the Public Opinion Index Reports of the Opinion Research Corporation. It is cooperating with the Association of Edison Illuminating Companies in a forest survey and with the National Association of Electric Companies in a special study of the tax situation, as it affects utility companies, with their special conditions of high investment per dollar of

output and the tax exemption enjoyed by their governmentally-owned competitors.

The special study of graphitization in pipes under high temperature and pressure, in which we have participated with the Association of Edison Illuminating Companies for three years, is nearing completion. It is gratifying to be able to report that this very serious menace to life, property and service has yielded to expert study and that alloys and methods have been discovered which in the future should make it possible to hold the threat within reasonably controllable bounds.

Our members may not realize how great is the volume of informational material the Institute sends out. In addition to the regular grist of data which goes out to members practically daily, our records show that, in the first four months of this calendar year, the Institute sold 445,000 copies of publications in the form of reports, handbooks, etc.—about equally divided between sales material and other publications.

Commercial Activities

We have the duty, as an essential part of our paramount service function, to do everything in our power, not only to render the best service practicable, but also to bring to the public, as widely as possible, information as to the many ways in which electricity can be of greater use, convenience and economy in the home, shop and factory and on the farm. Happily, this duty coincides with our own best interests, in that greater use makes for lower unit costs and hence more contented customers and more stable business. In fact, with relative maturity attained in the matter of manufacturing economy and with the present increasing costs of labor and materials (which, as stated, bid fair to eat up all the savings from reduced Federal taxes), our only hope, in keeping unit costs down to present levels, rests on the ability to market more of our product.

This duty rests squarely on our commercial forces and I am glad to be able to report that they are fully alive to their responsibilities. This spring's Sales Conference in Chicago brought out the largest attendance in the Institute's history. Our Commercial Committee has brought out recently, at a cost of $140,000, a comprehensive Sales Training Course, which has appealed very favorably to our member companies—so much so that its entire cost seems likely to be recouped from the sale of the material.

The growth in use of electricity in the home, noted earlier as occurring with practically no new equipment to offer, suggests much greater use when the new household apparatus becomes available. Some progress has been made recently with the development of the heat pump for house heating, which was so graphically presented to us by Mr. Sporn at our meeting here two years ago. It now seems feasible, with this miraculous device, to obtain a ratio of output to input of about four, using air as a heat source; and specifications are in preparation looking to a trial order of 1000 sets. If these work out as hoped for, the new frontiers of household load that will be opened up will be very wide indeed.

Rural Electrification

Government propaganda continues with unabated zeal to attempt to make of this basic subject a controversy between REA and the electric companies and, by implication, to belittle what the utility companies have done about it. It seems worthwhile for the record, since the Rural Electrification Act is now about ten years old, to restate the facts.

The term "rural," as applied to "homes" in the U. S. Census enumeration, includes not only farms but all homes in places of 2,500 population or under. Exclusive of the farms proper (what we call "rural non-farm"), our companies have for many years been serving practically as high a percentage as in the cities. This coverage was accomplished largely during the expansion of the Twenties and that job is practically done. What I shall say hereafter therefore refers particularly to farms as such.

The utilities began pushing their lines out onto the farms forty years ago; and by the end of 1935 they were serving about 789,000 of them. From the start, the long extent of line per customer proved an economic drawback to complete farm coverage. In 1935, in recognition of this economic difficulty and believing that government credit could properly be extended to bring electricity to those farms which, without this help, could not then get it, Congress passed the REA Act. During the ten years ending 1945, the REA cooperatives had connected 1,050,000 farms; but during the same period the electric companies and others had added 1,181,000, so that at the end of last year, of the total of 3,020,000 farms then connected, only about one-third were on REA lines.

These electrified farms represent about 50 per cent of the total farms in the country. But this figure reflects most inadequately the true accomplishment in farm electrification, in the following particulars: There are nearly 1,000,000 farms already reached by existing lines but not taking power; there are about 300,000 farms so remote as to be beyond all practical reach at any time; there are about 200,000 farms which are either without buildings or with their building not occupied. After making all these adjustments which add up to about 1,500,000 farms, the number of farms remaining to which lines could be built drops to about 1,500,000, or only 25 per cent of the total farms. Present plans by both the utilities and the REA are to reach most of this balance within three years.

After three years, therefore, the job of building lines to serve farms should be measurably completed. There will, however, still remain two big jobs to be done: (1) To get those farms which are reached but not served to use the service and (2) to help existing and future farm customers to get more benefit from their electric service. The complete working out of these two objectives in their respective territories will be a full-time job for both utilities and REA, without wasting effort in controversy.

The true controversies between the utilities and the REA arise in cases where REA departs from the limitations of its enabling Act (which confine it to places under 1,500 population) and invades company-served areas, or where it wastes public money by erecting duplicating power stations or transmission lines.

Interestingly enough, the REA has lately been reported to be having difficulty in persuading some of the cooperatives it has financed to extend their lines into adjacent territory more sparsely settled than their own—their hesitations arising from the fear that in so doing they will dilute their own earnings. Truly, history does repeat itself!

Service Standards

The constant effort of our industry from its earliest days has been to improve the dependability of our service. With respect to our large generating stations, especially as supported by interconnection, this goal has been attained; and with respect to major transmission lines, fast operating breakers on the one hand

and multiple interconnection on the other have measurably solved our problem. Both of these have to do with the supply of bulk energy; they still leave not completely solved the problems of maintaining service at the point where the customer uses it; for it is small consolation to the town customer, without lights, heat or refrigeration, or the farmer, without water or deep freeze or with unmilked cows, to know that the power plant and main lines are operating smoothly far away. The problem has two phases: One, increasing the dependability of our distribution lines in the face of wind or sleet and, two, how practically to help our customers in the matter of blown fuses or the breakdown of utilization equipment in the household or on the farmstead.

The first problem, dependability of lines, while largely an engineering matter, also involves operational features, and to both of these our Engineering Committees are giving study. In any event, it is our own problem. The second brings in the complication that most utilization equipment belongs to the customer, raising the question of how far the utility company should or can be responsible for property of customers, over which the company has no control.

The subject of service standards becomes more and more insistent in proportion as our service for a given customer moves from the status of a convenience to that of a necessity. For this basic reason, this subject will get more rather than less important with the passage of time.

Government in Business

We have now become thoroughly familiar with the entry of the Federal Government into the electric power business. In 1935 only 1 1/3 per cent of the electric energy generated for sale in this country was manufactured in Federal plants; in 1945 they manufactured 14 per cent. This difference is made particularly striking by comparison with municipal electric plants, which manufactured about the same per cent of the total energy (4.3 per cent) in both years.

The difference between the two (Federal and Municipal) in development during the decade just ended is the difference in basic setup. While each enjoys tax exemption, the municipal plants have to raise their own capital and pay the charges on it, while the money for the Federal plants comes from a supposedly bottomless Federal Treasury, without obligation to pay charges on the capital. With the municipal plant, the loss in local taxes and the charges on capital are plainly visible; but with the Federal plant, the burden is so widely diffused and so mixed in with other government operations as to be hidden from the average citizens, large though the total has now become.

At the present time some 4 billion dollars of money borrowed by the Federal Government has been invested in various power enterprises. These enterprises, subsidized by tax and interest exemption, represent a particularly serious competition because, in the utility business, with seven times as large an investment per dollar of sales as the average industry, charges on plant represent for the average utility about 50 per cent of their total costs. (With wholesale hydro companies this ratio is about 90 per cent.) On straight out operation, business-managed companies have always been more efficient than politically-managed government enterprises, but the present-day government subsidies represent too great a handicap for mere operating efficiency to overcome.

Nor have these governmental power enterprises represented merely the furnishing of service not otherwise available; but, on the contrary, in all too many cases, have represented deliberate duplication of facilities and raiding of company markets by an all powerful State. They exhibit in the aggregate a deliberate intent to overwhelm and destroy our business. It is inconceivable that a government of the people, set up to foster their interests, should set out to destroy a large section of those interests; but the record is unmistakably clear that this is what is occurring.

Signs are not wanting that the efforts of utility officials to bring these conditions to the attention of their representatives in government are beginning to have some effect. The sobering effect of our huge Federal debt is causing our legislators to scrutinize appropriations as they have not done in years; and a number of the proposed expenditures for wasteful duplications or unneeded power facilities have lately been drastically cut down or completely eliminated. Bureaucratic habits, built up over a decade, are not, however, easily broken, and the most constant and watchful vigilance on the part of our operating officials is needed to protect our companies from further government raids.

Holding Companies

When the Holding Company Act was passed by Congress about a decade ago it was based by its backers on the proposition that the evils existing with some holding companies could not, like other misdeeds, be eliminated by merely forbidding them but required the death penalty. This method of crime control seemed like a throwback to the Bloody Assizes of 1685, when people were hanged for stealing a loaf of bread. Yet, as enacted, the Act went even further and made the dissolution of holding company systems entirely independent of any alleged wrongdoing on the part of the systems so broken up. The arbitrary nature of this procedure does not seem to have been appreciated by the general public and so far the courts have found no constitutional reason to upset it, although it seems like a "cruel and unusual punishment." At the present time utility holding companies have been divested of about 4½ billion dollars of their assets and the process, so far as the Act permits, will probably be nearly complete in a few years. Looking back on the other developments since 1935, it would seem that the dissolution of holding companies was but a preliminary step in the effort by the Federal Government to weaken or destroy the electric companies so as the more readily to take them over as State enterprises.

Edison Centennial

Next February 11 will be the centennial anniversary of the birth of the founder of our industry. In preparing adequately to celebrate this anniversary, we have been obliged to recognize that the scope of Edison's genius was such that its celebration could not properly be confined to the electric utility business, since that represented only one of his many activities. We are therefore cooperating with a committee of 95, under the honorary chairmanship of Henry Ford, the chairmanship of Charles F. Kettering and the vice chairmanship of Frank M. Tait, which has been set up for the purpose by the Edison Pioneers. This committee, besides a dozen electric utility men, includes educators, publishers and Army and Navy representatives and outstanding men in such varied fields as automobiles, moving pictures, chemistry, mining, radio, engineering and farming.

While, therefore, we must consent to share with other beneficiaries of his genius the privilege of honoring Edison's achievements, we expect to have a substantial part in the centennial celebration and have designated a special com-

mittee of our Board of Directors to develop the details of our participation.

It is no derogation whatever to the genius of the founder of our industry to recognize also the great services that others have rendered in the development and perfecting of the well nigh universal electric service we know today. The brilliant and determined work of George Westinghouse during the first decade of our industry history in the use of alternating current for transmission and distribution of electricity was essential in this process. It transformed what without it would have remained a highly localized service into the existing widely dispersed service, even to remote hamlets, and the great high tension transmission networks which have made that development both feasible and dependable. Interestingly enough, these two great pioneers were born within about four months of each other. The roster of great men who have built upon the foundations laid by Edison and Westinghouse is too long to include in my report; their achievements are integrated in the great electric service of our time.

Present Day Problems

Our present struggle is with what Owen Young described, twenty-four years ago, as "the danger that the growth of our industry will outrun public understanding; that people will see and fear our size without understanding our service." Since our industry output today is over four times what it was when Mr. Young made that penetrating statement, it is clear that this danger is greater today than ever. This danger is now being tackled on two main fronts. The first of these, begun five years ago, is the advertising and radio campaign being carried on by the 170 electric light and power companies comprising the Advertising Group, under the expert advice of N. W. Ayer & Son. The second is the work inaugurated about a year ago by the National Association of Electric Companies 107 in number, under the capable leadership of Purcell L. Smith, in arranging for operating company officials to advise the Congress, through its committees, of the facts surrounding such proposed legislation as directly affects such companies. To both of these activities the Institute has made available its great store of factual information—thus both enlarging the scope of its effectiveness and avoiding duplication of expense, while at the same time maintaining the disinterestedness so essential for the production of dependable data.

In closing this, my last annual report to you, I should like to add a personal word. I have always felt that our business was the most interesting, as well as the most stable, in existence. What other business furnishes such a worthwhile service? What other business could like ours stand the combination of increasing costs and decreasing rates and constant attack by government, armed with heavily subsidized competition, and still come up smiling? The broad view of the electric utility business obtained from the vantage point of the presidency of the Institute has not only confirmed by long-held optimistic attitude toward the industry, but has left me also a priceless legacy of many close friendships with its able and lovable leaders. I shall never lose my affection for or loyalty to our industry; and if the occasion ever arises in future where my experience can be useful, I shall be proud to be called on to help.

The Institute's Annual Meeting

(*Continued from page* 182)

have exceeded expectations, W. V. Merrihue of the General Electric Company, announced. This long-range plan to accelerate the modernization and electrification of American industry has as its goal an average industrial use of 6 kilowatthours per manhour employed by 1950, he said.

Sixth General Session

Labor relations in the utility industry have been better than in those industries more seriously affected by the impact of reconversion, H. K. Breckenridge, Assistant to the President, West Penn Power Company, Pittsburgh, Pa., told the meeting. Expanding employment opportunities, and non-curtailment of operations, have been helpful in this regard, he explained.

No national pattern of wage increases is apparent in the industry, Mr. Breckenridge continued, adding that strikes and strike threats have presented some serious problems to management. The recent New Jersey law providing the rules for collective bargaining in utilities, and forbidding strikes, is not what either employers or unions want, he said.

Unionization of foremen and supervisors will offer many difficulties, and thoughtful managements are already considering this problem.

The aims and purposes of the National Association of Electric Companies were described by P. L. Smith, President of the Association, in a brief outline. "A broad dissemination of facts and understanding of the industry is essential," he said, and this requires careful appraisal and decision concerning national public relations. Present efforts are met with "cries of power trust lobbying," accompanied by distortion of the truth, he said, but "meritorious presentation of facts, even though it is attacked, will eventually win understanding and intelligent public opinion," Mr. Smith said.

Grover C. Neff, President of the Wisconsin Power & Light Company, Madison, Wis., and newly elected President of the Edison Electric Institute, called for cooperation between utility companies and REA co-operatives in working out in a friendly way a division of the territory yet unserved, based upon the sound economics of each case.

Unless the two principal agencies furnishing electric service get together and make practical, sensible agreements and arrangements for rendering rural service, it will not be furnished in the best and most economical manner, Mr. Neff stated. It is in the best interests of the industry, he maintained, that each operating company executive see to it that lines are extended on an area basis and as rapidly as possible into all territory that logically falls to his company.

The volume of tax-exempt business has increased tremendously within the last two years, B. C. McCabe, President of the National Tax Equality Association, told the meeting in the last scheduled address. The 1945 volume of business done by cooperatives was $12,000,000,000, he stated, in enterprises ranging from rouge and lipstick to farm machinery factories.

Cooperatives plan to expand still further, and their expansion will be aided by what Mr. McCabe characterized as unfair avoidance of the Federal income tax. His organization is waging a continual fight for income tax equality in all business, he said, adding that "cooperatives have plans that will take you over, if they get away with making the new rules of business."

Progress of Rural Electrification in United States

By G. C. Neff

President, Wisconsin Power and Light Company;
President-Elect, Edison Electric Institute

Address before the Annual Meeting of the Edison Electric Institute, New York, N. Y., June 5, 1946.

THE FEDERAL CENSUS REPORT for April 1, 1930 showed 6,288,000 farms in the United States. The Census Report for April 1, 1940 showed 6,090,000 farms, and the preliminary estimate of the census people for December 31, 1945 showed 5,950,000 farms in this country. The number of farms is decreasing and the average size of farms is increasing. This trend will probably continue as agriculture becomes more and more mechanized.

As of December 31, 1945, 3,020,000 farms or 50.8 per cent of all farms in the United States, were using electric service. In addition, the electric lines that serve a little more than half the farms in this country bring electric service within easy reach of many other farms where, for one reason or another, the farm homes are not connected to such lines. Many of these unserved farm homes are located immediately along existing lines. Others are from a few hundred feet to a quarter of a mile away from such lines.

Two-thirds of All Farms Reached

It is estimated that 900,000 farm homes in the United States that are not taking electric service are within one-quarter mile of existing electric lines. We say these farms have been reached because the farmers in most all cases can have electric service whenever they elect to take it. Therefore, the total number of farms reached by electric lines in the United States as of December 31, 1945 is 3,920,000 or about 66 per cent of the total farms in the country. In other words, about two-thirds of all the farms in the United States have been reached by electric lines and about one-third are yet to be reached.

As of December 31, 1945, the electric operating companies were serving 1,811,000 farms, REA co-ops were serving 1,050,691 farms, and all others were serving 159,000 farms. Inasmuch as the operating companies serve 60 per cent of all farms served, it can be assumed that 60 per cent of the 900,000 farms reached but not served are along the lines of operating companies and that as of December 31, 1945, the operating companies had reached 2,351,000 farms. Inasmuch as REA co-ops are serving 34 per cent of all farms served, we can assume that 34 per cent of the farms reached but not connected are along co-op lines, so REA co-op lines have reached 1,356,000 farms. All other agencies serve about 6 per cent of all farms served, so we can assume that 6 per cent of the 900,000 farms reached but not connected are along their lines and that these agencies have reached 213,000 farms.

600,000 More by 1948

Surveys conducted by the Edison Electric Institute indicate that operating companies will connect 200,000 additional farms in 1946. It is a fair assumption that an equal number will be connected in each of the two years following, making a total of 600,000 farms to be connected by operating companies during the three year period ending December 31, 1948. This will make a total of 2,951,000 farms reached by operating companies as of December 31, 1948.

To determine what REA co-ops are likely to do in this same three-year period, a study has been made of what they did in the three years from June 30, 1938 to June 30, 1941. This prewar period was the time of greatest REA activity. According to the REA records, the number of customers connected to REA co-ops during this period was 674,933. These were not all farm customers. According to REA reports, as of December 31, 1941 approximately 80 per cent of all their customers were farms, so REA probably connected 540,000 farms during these three years of greatest activity. The REA co-ops may be able to do a little better in the three-year period from 1946 to 1948 inclusive. If they extend service to 600,000 farms in these three years, they will have brought electric service within easy reach of 1,956,000 farms by the end of 1948.

It is estimated that all the other agencies will connect 40,000 new farms in the same three-year period and that these agencies will then have brought electric service to within easy reach of 253,000 farms.

The forecast, then for December 31, 1948, is that 5,160,000 farms will have been reached by operating companies, REA co-ops, and other agencies. Inasmuch as there are now only 5,950,000 farms in the United States and the number is decreasing, and inasmuch as many of these farms do not have any buildings on them, it can be seen that the big job of extending electric lines to the farms of this country will be about completed on December 31, 1948.

It is true that there will be quite a large number of farms along existing lines that will have to be connected, and *short* extensions will have to be built in many cases, but those developments will be taken in stride and will not present a big construction or financing problem.

No Financing Difficulty Expected

There isn't any question about the ability of the operating companies to finance this program during 1946, 1947, and 1948. A study of the REA financial picture shows that they have plenty of money. According to the United States Department of Agriculture, Rural Electrification Administration, Monthly Statistical Summary, as of January 31, 1946 the total amount of money appropriated by Congress for use by REA was $725,628,288. The amount actually advanced to REA co-ops was $467,991,586. It is possible that not all of the funds advanced have as yet been spent by the co-ops, but at any rate the co-ops have received this amount of money. This leaves $257,637,000 of funds appropriated that have not yet been advanced to the co-ops as of January 31, 1946. On March 22, 1946, Public Law 329 was enacted, providing $100,000,000 additional money to REA in the Urgent Deficiency Bill of 1946. There is at present pending an additional appropriation of $250,000,000 for REA in the 1947 Appropriation Bill. It has passed the House, but has not as yet been acted on by the Senate. REA,

therefore, has available $357,000,000 of funds not yet advanced to REA co-ops, and if the Senate passes the 1947 appropriation bill as now written, REA will have over $600,000,000 of funds to advance to REA co-ops. That is 40 per cent more money than they spent in the whole ten years of their existence. REA has plenty of money to carry on the above-outlined construction program for the years 1946, 1947, and 1948 even if the Senate does not grant them the $250,000,000 included in the 1947 Appropriation Bill.

The only thing that could delay the carrying out of the program outlined above would be shortage of materials, but it is probable that materials will be available in sufficient quantities to permit the operating companies, REA co-ops, and other agencies to carry through their construction programs.

Connecting Farms Only Part of Our Job

The job of proper rural electrification is not finished when all farmers who wish to have electric service have it. The principal objective of rural electrification, in addition to furnishing light, is to get electric power efficiently applied to as many farm jobs as possible in ways that are profitable to the farmers. The building of electric distribution lines is necessary but is only a means to an end, and a farmer does not necessarily have profitable rural electrification when a line has been built and service made available in his house and barn. As utility people, we have a big job on our hands to do whatever we can to get electric service at work on the farms of our customers in a manner profitable to the farmers.

During the past twenty-five years, a great deal of progress has been made in improving farm machinery and equipment used in the field so that one man can now do as much work as was formerly done by two or three men. With the constantly increasing cost of labor, the farmer has to rely more and more on machinery and automatic equipment in order to hold down his labor costs to a reasonable amount. Around the barn and other farm buildings, the farmer is still doing many things by hand in very much the same way as they were done twenty-five years ago. It is for these jobs that electricity, working through automatic equipment, can be of great help to the farmers in carrying on their farm work.

In a number of states, the utility companies and various farm organizations are working with their respective state universities in carrying on research and experimental work, trying to find better ways of applying electric power to farm operations. In this way much excellent work is being done which will result in reduced cost to the farmers and increased business to the utilities. This kind of work might well be supported by all utility companies that have any rural business. It is hoped that most states will organize themselves to carry on research and experimental studies of this kind.

More Rural Representatives Needed

As new and better ways are found to apply electric service to farm operations, the farm customers must be made acquainted with the new and better methods and sold on the use that they should make of them. This calls for action on the part of the company furnishing the service. In order to do this properly, each such company needs a number of men who understand farming and who understand the application of electricity to farm operations. To get the farmers to make use of the new and better methods, these men will have to spend time talking to these farmers and selling them on the benefits they will receive by applying electricity to their particular farm activities. It seems to me that it requires, as a minimum, one man of this type for each 1,000 farm customers. There are very few power companies in the country who have that many people contacting their farm customers, and to that extent I believe the development of the farm load is being neglected. Since there are 1,811,000 farms served now by operating companies, it would require, as a minimum, 1,811 rural representatives to do this type of work.

You executives of utility companies have probably authorized the spending of $600,000,000 on farm electric distribution lines alone. But the customers connected to these lines are not very familiar with electric service. It is a new field to them, and they are just getting started in it. It is our most undeveloped class of business. If you will analyze this class of business as you analyze your residential business and your power business, I believe you will recognize the need of adding to your operating force a sufficient number of properly trained people to intelligently push the development of this new farm business. In my opinion, bigger and more profitable results can be obtained in this field at this time than in any other class of our business. The investment we have made in it is so big that we cannot afford to neglect it.

During the past ten years, when hundreds of millions of dollars were being spent by operating companies and REA co-operatives in the building of farm electric lines, conflicts were found to occur here and there, and harsh and unfair things were said by both sides. That same condition existed between different utility companies back in the days when there was rapid expansion of transmission line construction throughout the country. After this rapid expansion was over and most of the cities and villages had received electric service, the utility companies got together and forgot the contests and difficulties of that rapid construction period. They made intelligent studies of the territory yet to be served, reached agreements among themselves as to what company could best serve certain areas, and worked out the best way to do it. It seems to me that we are now rapidly approaching a time when electric lines, owned either by operating companies or by REA co-ops, will practically cover the entire tillable area of this United States. The period of rapid expansion will be about over on December 31, 1948.

Understanding with Co-ops Urged

We in the utility business should realize that REA co-ops are here and that they will continue to furnish an appreciable part of the farm electric service used in this country. These co-ops will be operating in territory adjacent to that served by the operating companies. It seems to me that it would be wise for us to approach their directors in a spirit of friendliness and in a cooperative manner. It should be possible to work out with them, in a friendly way, a division of the territory yet unserved, based upon the sound economics of each case. That is, let the operating companies serve the farmers nearest the operating company lines and let the co-ops serve farmers nearest their lines. If the operating companies prefer to have the co-ops build the distribution lines to a greater extent than this, then wouldn't it be a good thing to meet with them and have a definite understanding with them on just what the co-ops are going to do and what the operating companies are going to do? Such a plan, if it can be carried out, will

bring order to the development from here on in and should result in benefit both to the co-ops and the operating companies.

I am fully aware of the fact that there appears to be a decided effort on the part of certain leaders to use the REA co-ops as a vehicle for developing government-owned power through which they hope to socialize our business. But it is my belief that the big majority of farmers who are on the boards of directors of the various local REA co-ops will oppose a program for socializing the electric power industry if it is established that this is the objective.

Anyway we must not let the short-sighted policy of a few leaders prevent us from doing the thing that we know is necessary to bring about the best service to the farmers of this nation. Unless the two principal agencies furnishing the service get together and make practical, sensible agreements and arrangements for rendering rural service, it will not be furnished in the best and most economical manner. It seems to me that a utility company operating in a territory in which there are REA co-ops should have a definite program of contacting the people who run the co-ops to discuss with them the many problems that arise in each case until there is a complete understanding.

While the job of line building is about two-thirds finished, there is still much to be done. Many companies are doing an excellent job of extending service into territory not yet serviced, others are doing only a fair job, and others are doing nothing at all. It is in the best interests of our industry that every operating company executive take another look at how his company is carrying on its rural electric service work and that he see to it that lines are extended on an area basis and as rapidly as possible into all territory which logically falls to his company.

Suggests Study of Extension Policies

In other words, when we have determined upon the areas we should logically serve and wish to serve, let us proceed with the building of the lines in such a way that the service is extended as promptly as possible to all in the area who wish service. As far as I know, most companies are now extending on an area basis, but our critics have been contending that we do not do this. They charge that we build lines which take the cream of the business and prevent anyone from serving the lean business in the territory. This has probably happened in some cases, but I do not believe it is fair criticism at this time. Nevertheless, it might be advisable to have another look at our rules covering extension of electric services to farmers. We may wish to liberalize them or modify them so that they are not subject to such criticism. It may be better for our separate companies and for the industry as a whole to encourage REA co-ops to serve the areas that we are not willing or able to serve promptly on an area basis.

It has been difficult to get materials and supplies and manpower during the past four years to extend farm lines. However, where the necessary effort was put forth, as was done in a number of companies, many thousands of miles of line were built during these years. During 1945, two Wisconsin companies that I am quite familiar with each added more than 2,000 farm customers, so it is possible to build farm electric lines even in these times. My hope is that we do not wait, but start now to do what we can to extend this much-needed service to the farmers in the territories served by our respective companies.

Intensified Publicity Program Needed

We in the utility business should review the publicity programs of our com-

(*Continued on page* 198)

New Jersey Power & Light Co. Wins Annual Report Contest

NEW JERSEY POWER & LIGHT COMPANY, Dover, N. J., is the winner of the annual award offered by Reddy Kilowatt Service for the electric light and power company producing the best annual report, it was announced at the E. E. I. meeting on June 3.

HUGH C. THUERK
President, New Jersey Power & Light Company

The award, a handsome bronze plaque, was presented by Ashton B. Collins, of Reddy Kilowatt, to Hugh C. Thuerk, president of the New Jersey company, during the meeting.

The winning report consisted of a 24-page booklet, printed in two colors, with numerous charts, graphs and photos. The judges' citation said in part:

"This report tells what the company has been doing, not only as a business, but in its important job as citizen of the community it serves. It is written simply, with not too many statistics, but just enough, and these are well shown. The overall feeling is that the report is very friendly, as well as optimistic as to what the future holds.

"The addition of a table of contents, as well as a specially inserted map, add much to the report. The center spread, showing the 10-year record of the company, is very well handled."

The following companies received Honorable Mention:

Kansas Gas & Electric Company, Witchita, Kans.

Northern States Power Company, Minneapolis, Minn.

Pennsylvania Power & Light Company, Allentown, Pa.

The objects of the competition are to encourage clarification of annual reports, to help the average stockholder to understand the year's operations of the company. Among the chief requirements of the contest are that the report must be in simple language, must dramatize accomplishments and build good will.

The judges were:

Merryle Stanley Rukeyser, economic analyst and financial writer.

S. B. Williams, Editor, *Electrical World.*

H. S. Bennion, Vice-President and Managing Director, Edison Electric Institute.

Kellogg's Retirement Terminates Distinguished Career in Electric Industry

THE RETIREMENT this month of Charles W. Kellogg, President of the Edison Electric Institute, officially terminates a career of 43 years of distinguished service to the electric utility industry. During this time, Mr. Kellogg served as an operating and a holding company executive, and during the last ten years as head of the principal trade association of the electric utility industry.

CHARLES WETMORE KELLOGG

Mr. Kellogg has seen the industry advance from a 1903 total of 583,000 customers to 34,031,073 in 1945: from a generating capacity of 1,212,235 kilowatts in 1903 to 50,102,422 in 1945; from a customer use of 2,507,051,115 kilowatthours in 1903 to 222,433,981,000 kilowatthours used in 1945, with a decrease in average cost, to residential customers, of 15.4c. per kilowatthour in 1903 as compared with 3.41c. for each kilowatthour in 1945.

Born in Philadelphia in 1880, Mr. Kellogg received the degrees of BS (1902) and MS (1903) from Massachusetts Institute of Technology.

After graduation, he joined the utility concern of Stone & Webster—a connection that was to last for 36 years.

He was appointed manager of the Edison Company in Brockton, Mass., a Stone & Webster affiliate, in 1905. Mr. Kellogg shortly thereafter was transferred to Texas, where he spent nine years as manager of Stone & Webster operating companies in El Paso and the Gulf Coast area.

From 1914 to 1919, he was the manager of the Mississippi River Power Company at Keokuk, Iowa. During the latter part of this period, he was also the manager of Stone & Webster's Middle West District.

Assigned to the Stone & Webster Boston office in 1919, Mr. Kellogg spent the next six years in work on appraisals, reports, etc., including an examination for the Interborough Rapid Transit Company, New York, N. Y., and a report on the Conowingo Hydroelectric dam on the Susquehanna River in Pennsylvania. He also organized and conducted securities sales campaigns for operating companies.

Mr. Kellogg was elected President of Engineers Public Service Company shortly after its organization by Stone & Webster and associated interests in 1925. He became Chairman of the Board in 1933, and continued in this post until 1939.

He served as part-time, non-salaried President of Edison Electric Institute for three years, in addition to his duties with Engineers Public Service Company. His work with the trade association was so outstanding that the Institute's board of directors prevailed upon him to take the post as a full-time responsibility. In 1939, he resigned from his Engineers Public Service connection, and became the Institute's salaried full-time President.

A year later, in June 1940, he was asked to serve for a three months' period as Chief Consultant of the Light, Heat and Power Unit of the Defense Commission, predecessor of the War Production Board. On leave of absence from the Institute, this three months' period was extended to a full-year, in which he devoted practically all of his time to organization of the public utilities in the defense program.

In addition to his regular duties, Mr. Kellogg found time throughout his career to prepare numerous contributions to the literature of public utility operations and economics. He also served as the representative of the electric utility industry on many national committees and organizations.

Genuine regret over Mr. Kellogg's retirement is felt both by his immediate associates at Edison Electric Institute Headquarters and throughout the industry, generally. He reached the retirement age of 65 early in 1945, but by special action of the Board of Directors he was empowered and urged to continue as president of the Institute through the administrative year expiring this month.

At a meeting of the Board of Directors of Edison Electric Institute, held June 4, Mr. J. M. Barry speaking for the membership of the Board, paid glowing tribute to the capable and devoted services of Mr. Kellogg through ten difficult years in the history of the Institute. In a rising vote of thanks the Board expressed its sincere appreciation to Mr. Kellogg and wished him many years of happy enjoyment of the fruits of a lifetime of usefulness.

In its issue of June 6, the New York *Times* commented that his retirement marked the end of service to the industry "of a man who had a distinguished career of forty-three years of service in the industry, during many of which he was president of one of the largest elec-

(*Continued on page* 204)

The Utility Industry's Interest in the Establishment and Growth of Small Industries

By Thomas N. McCarter, Jr.

Executive Vice President, Public Service Corporation of New Jersey

Address before the Annual Meeting of the Edison Electric Institute, New York, N. Y., June 4, 1946.

IT is a pleasure to talk on the establishment and growth of small industries because in the territory in which I work we have a goodly portion of it, and have many examples and experiences to draw from. The area covered is about 1700 square miles between Jersey City and Camden. There is wide diversification and no single industry or group of industries dominate the whole area. The billed demand of our industrial customers is in excess of 500,000 kw and in 1945 our sales to these customers were in excess of 2,800,000,000 kwhr for approximately $32,300,000 of revenue. Of more than 5000 of such customers there are at least 4700 which classify as small industries. To us small industries mean companies with perhaps one or two employees and using a very small amount of electric service, perhaps a motor or two to drive machine tools, up to firms with electrical requirements of maybe 500-kw and several hundred employees. These industries are considered small because of the fact that they have, in general, little business counsel and limited technical assistance from their own employees, depending primarily on the ingenuity of the owner in manufacturing and processing lines to make an ultimate success of the business and to secure national distribution of the product.

Importance of Small Industries

We are particularly interested in the success of such small industries for several reasons:

1. Industrial history in the United States is filled with sensational achievements. We can point to the business of the Johnson & Johnson Company at New Brunswick, the Campbell Soup Company at Camden, the John A. Roebling Company at Trenton, the Thomas A. Edison Company in West Orange; all of which had their start in a very modest way and expanded in the location in which they were started. In an industrial territory when you have almost 5000 so-called small industrial customers you are bound to have some of them expand and become large nationally known industries. By its very nature it is a splendid spawning ground for future big industry.

2. The health and growth of industry in any utility territory is vital to any expansion and future growth of residential and commercial communities and the resultant electric revenue derived therefrom. Expanding industrial firms will draw new employees into a particular area. The payroll of these firms will be used to construct houses, to purchase electric appliances and to pay for the electric energy so used. The payrolls of these firms also will be used to purchase food, clothing and other goods in the immediately surrounding neighborhood. This will stimulate commercial construction which in turn requires electricity for its operation.

Greater Sales Stability

3. From the standpoint of industrial sales stability we are also vitally interested in the establishment and growth of small industries. Local markets will often provide adequate support for a wide diversity of products and small plants. Energy sales to these customers will be subject to less variation during depression periods.

4. The growth of small industrial enterprises will train men in certain skills, chemical processes, machine tool work, welding, ceramics, leather finishing and in many other of the various trades. This will gradually create a stabilized labor pool from which our larger industries may then draw. If I were moving into a new territory with a modern plant a location in which there was such a labor condition existing would attract me far more than one in which most of the labor was unskilled. Labor in a small plant is close to management, has pride in production, in quality and in quantity. Direct supervision is possible. Individual initiative receives full encouragement. Labor trained in this way should provide a healthier condition in the community.

These are the basic reasons for our interest. They are not all altruistic. I will take five firms that had very modest beginnings and now have attained national distribution of their products; five firms that our electric company has helped somewhere along the way with information and assistance on the application of electric power and improved production methods, and five firms that we are proud of and of our part in their development.

5 Case Histories

Company A. This company manufactures canvas and leather golf and sports bags among other things. Its war products were knapsacks and tents. Starting in business in 1924 with eight employees and 1800 square feet of floor space, this company gradually expanded its sales from $112,000 in 1925 to $550,000 in 1935, $1,400,000 in 1940 to $5,200,000 in 1945 with a further increase anticipated this year. In 1945, the employees had increased to 550 with an annual payroll of $1,150,000 and an electrical load of 121 kw, for 275,680 kwhr and $6260 of revenue to us per year. I recognize that I am dealing with certain figures in wartime production but these firms were not started as war babies and their future is assured.

Company B. This company manufactures artificial leathers. It was started in 1920 as a partnership in a small building by two ambitious brothers with two helpers and a capital of $8,000. One of the brothers was a salesman for a leather company and the other a bookkeeper for the same firm. In 1923, they incorporated and in 1925 their business had increased to $734,000 a year with 160 employees. Sales expanded to $2,725,000 in 1940 and $6,285,000 in 1945 with 460 employees. The electrical load grew to 790 kw in 1945 for 2,826,600 kwhr and $34,368 per year.

Company C manufactures cathode-ray tubes for radar, television, oscillographs,

control and switching applications as well as television receivers and transmitting equipment. The man who is now president started in a basement laboratory in his own home about 1931 with four other people helping him. The total sales of 1931 and 1932 amounted to $1920. Expanding from first one store to five in Montclair, the company rented space in Passaic and now has four large plants with several hundred thousand square feet of floor space. Sales expanded to $36,000 in 1935, $176,000 in 1940 to $6,970,000 in 1945 with 1090 employees. War stimulated growth, I acknowledge, but the 1947 forecast estimates $18,000,000 of sales.

From 2 to 200 Employees

Company D is a manufacturer of refrigeration coils and allied products. Starting business in 1914, two brothers as the owners and the only workmen engaged in the manufacture of replacement radiators for Ford Cars. In 1933, this market collapsed and the manufacture of refrigeration cooling coils was commenced. The firm has designed and patented many refrigeration items used by leading manufacturers in this field. Sales expanded from $250,000 in 1933 to $450,000 in 1936, $600,000 in 1939, and $1,400,000 in 1945, with 1946 sales projection of $1,750,000. From an initial floor space of 1500 square feet this company now occupies 80,000 square feet. The number of employees increased to 200 in 1945 and the power load to 294 kw for 673,000 kwhr and $14,400 revenue.

Company E is a manufacturer of over 2000 products used in the processing of such goods as textiles, leather, paper, glue, paint, varnish, lubricants or as ingredients in foods, feeds, pharmaceuticals, and pharmaceuticals themselves. The company started in business in Newark in 1907 in one rented basement room with one employee, $300 in capital, and one formula for making sulphonated oil for the textile industry. Within a year the company outgrew its basement and purchased a vacant lot in Harrison and built a one story frame building. The company became the largest importer of cod liver oil in the country and investigated its value as a source of Vitamins A and D for poultry and animal husbandry. Under a sole license from Dr. Zucker of Columbia University for a vitamin extraction process from cod liver oil, the company has become prominent in this field. In 1937, the company established a branch plant in Cedartown, Georgia. Sales have grown through the years and amounted to $8,448,000 in 1940 and $15,270,000 in 1945. The number of employees at Harrison increased to 450 in 1945, and the power load to 450 kw for 1,898,160 kwhr, and $24,572.

Let's look at a summary of the contribution of these industrial customers to our business in 1945. In addition to industrial revenues of $114,000, let's see what residential and commercial revenue can be attributed to these firms with a total payroll in that year of around $7,000,000.

Contribution to Residential Revenue

On the basis of census figures of the ratio of heads of families to total employed and the assumption that heads of families are residential customers, these five firms were indirectly responsible through their employment of 2750 persons in 1945 for $82,000 of our residential revenues.

Also on the assumption that the commercial enterprises in the territory are established to serve the needs of the customers living in these areas, we have a conservative estimate of the commercial revenues indirectly attributable to the employment in these industrial plants of $71,000.

It is interesting to note that the industrial revenue amounts to only 43 per cent and the residential and commercial revenue amounts to 57 per cent of the grand total of $267,000.

Company	*Employees*	*Industrial*	*Residential*	*Commercial*
Company A	550	$6,000	$16,000	$14,000
Company B	460	34,000	14,000	12,000
Company C	1,090	35,000	33,000	28,000
Company D	200	14,000	6,000	5,000
Company E	450	25,000	13,000	12,000
	2,750	$114,000	$82,000	$71,000
Industrial Revenue			$114,000	43%
Residential and Commercial Revenue			153,000	57%
Total Revenue			$267,000	

Certainly, we will all agree as to our interest in and the importance of the growth of small industries in our respective territories and now is the time for action. With much of small industry handicapped by the lack of materials, pricing regulations, and some labor problems, these industries are going to need help if they are to survive and grow.

How we can help them and what we can do for them is going to vary for every State. It is going to vary with industrial conditions in our respective territories. Perhaps, one of the most outstanding jobs that has already been done along these lines is the "Better Home Town" program, which many of you have heard Charles Collier, Vice President of the Georgia Power Company, discuss in which their local Chambers of Commerce were active and in which the local utility shared a large part. Over 400 industries were established, with 18,000-hp connected load, and with between 6000 and 7000 employees. This program as it is continuing will do much to stabilize the labor market in an area which had been losing population and industrial enterprises to other sections of the country, and it will certainly provide worthwhile revenues to the Georgia Power Company.

How Utilities Can Help Small Industries

From a community standpoint the utility companies are perhaps the most logical organizations to encourage the establishment and growth of small industries in an area. Through their activities they are in a position to assist Chambers of Commerce and other local agencies in creating a favorable industrial climate. They are in a position where they can readily help to establish and assure good business counsel to new industries. It is an obligation which they have at this time when hundreds of new business enterprises are being started by former GI's and others.

From a second standpoint, they are also in an admirable position to help small industries. That is, because these industries have little access to technical and engineering assistance. The Industrial Section of the General Sales Committee of the Edison Electric Institute has suggested that the concentration of activities of all utility power salesmen on the study of customer's production methods can be of the utmost help in aiding the small industry to increase production and decrease costs. It is the basic ap-

(*Continued on page* 216)

Résumé of

A Factual Analysis of the TVA

By Huet Massue
B.A. Sc., C.E. M.E.I.C.
Consulting Engineer, Montreal, Canada

Resumé of a Presentation before the Annual Meeting of the Edison Electric Institute, New York, N. Y., June 5, 1946

THE Tennessee Valley Authority, foremost experiment of government in business, was pictured before the Edison Electric Institute's annual meeting today as a "costly and uneconomical" project, with a reported investment that is far below reality, and altogether fictitious operating costs reported in its financial statements. These conclusions were made by Huet Massue, consulting engineer of Montreal, Canada, in a summary of the results of an extensive study and analysis of the TVA made by him.

"Under the foregoing circumstances, the much talked about 'yardstick' of cost of electricity is comparable to, and has as much sense as, a 5-inch foot or a 6-ounce pound," Mr. Massue said.

"Enforcement of arbitrary yardsticks such as TVA cannot but bring about ruination of all privately-owned institutions having to pay interest on their funded debt, dividends on their capital, and having to meet the ever increasing taxation which subsidization of their competitors necessitates," he continued.

Before presenting his analysis of the TVA, Mr. Massue explained how he had become interested in the Authority.

"We in Canada heard so much about TVA and what it was doing for the southern section of your country," he remarked, "that we all became very much interested in its operations. We heard such favorable things about it that most of us were led to believe it had uncovered some magical way of getting work done much cheaper and better, of producing electricity far cheaper than private capital through its engineering and organization had been able to do, and to build up a region economically far better than the capitalistic system had been able to accomplish.

"As an engineer who had made many engineering studies in my own section of the continent, and who had made engineering studies for Canada," Mr. Massue continued, "I felt induced to make an overall examination of the expenditures and accomplishments of the TVA, to see for myself how they compared with other engineering developments with which I was familiar through experience and study.

"As I proceeded with my investigations, I saw that TVA had not found a cheaper way of getting work done; that it had expended large sums of money on uneconomic projects, but that it had been extraordinarily successful in creating the impression that its operations were financially profitable."

Actual Cost of Wilson Dam

Wilson Dam, original cornerstone of TVA and by far the largest of its hydro-electric plants, is a specific example of far understated costs, as a result of the government's habit of neglecting to calculate interest as an operating cost in its projects, Mr. Massue said. Begun in 1918, at no time before being taken over by TVA in 1933 had revenue obtained from its operation met the full cost of its management. Three years later, Wilson Dam's record of costs to the U. S. Treasury and losses amounted to $86.3 million, according to the following figures cited by Mr. Massue:

Spent by Corps of Engineers	$47.1	million
Interest on advances made by the government	39.1	"
Cost of overhead to government	5.7	"
Taxes lost	0.9	"
Gross Total	$92.8	"
LESS Revenue received from 1925 to 1936	6.5	"
Net Cost	$86.3	"

Yet when TVA took over the dam, its announced cost to TVA was $31.5 millions, which meant that the U. S. Treasury had absorbed $54.8 million of the actual development cost of Wilson Dam, according to Mr. Massue.

Capital Cost of Entire TVA Development

Analyzing the capital cost of the entire TVA setup, Mr. Massue stated that on June 30, 1945, the total liabilities were reported by TVA at $778 million, of which $12 million represented current liabilities, $60 million was funded debt, and $706 million was appropriations of the Federal Government.

By including the true total cost of Wilson Dam, with operating losses resulting from the TVA operation between 1934 and 1945, the capital cost of TVA is brought to $821 million, Mr. Massue said.

Had the Authority paid interest on its government appropriations, as would a non-subsidized business, an additional $152 million would have been required, he said, which would increase the capital cost to $974 million.

By including the loss of taxes to the government, caused by nationalizatoin of electric service in the Tennessee Valley, the real capital cost of TVA is brought to over one billion dollars, Mr. Massue stated.

TVA's Cost Compared to Private Hydro Stations

Comparing the cost of TVA power development with that of private power projects, Mr. Massue presented a chart comparing the investment in TVA hydro stations with that of representative power companies in the United States and Canada on an actual yardstick basis. For this purpose, Mr. Massue used the dollars invested per "kilowatt-year" (kilowatt-year of a generating plant is defined as that capacity of generating machinery which, if operating continuously throughout the year, would produce electricity in amount equal to the plant's actual output of electricity for the year).

His statistics calculated on this basis showed the unit cost of TVA's "Kentucky" hydro station, as an example, to be more than thirteen times the unit cost of hydro plants in Quebec, more than eight times the unit cost of hydro stations to the Duke Power Company, and more than six times the unit cost of plants built by Southern Calfiornia Edison Company.

"It is necessary to remember that the TVA figures represent only part of the cost of development, as no interest charges have been taken into account,"

Mr. Massue said. "Had interest charges been calculated, the TVA cost figures would have been increased by about 20 per cent."

The investment of TVA in its hydro projects averages $338 per actual kilowatt installed, which is more than twice as high as the average investment in hydro facilities of privately-owned electric utilities in the United States ($167) and in Canada ($162) he reported.

Figured on a "per kilowatt-year produced" basis, the average TVA investment in hydro stations is $528 per kilowatt-year, slightly less than twice the average investment of privately-owned plants in the United States ($290) and about two and a half times as large as the $240 invested in Canada, Mr. Massue stated.

This high cost of TVA projects explains the reason back of the arbitrary allocation of costs of power, flood control and navigation, Mr. Massue said. To arrive at a reasonable cost of production, the investment in power facilities is shown as low as possible, the figure for 1945 being about 40 per cent of the actual total cost, in his opinion.

TVA's Operating Costs

Turning to the reported operating costs of the TVA, Mr. Massue pointed out that the $30.1 million reported for 1945 would have been increased to $55.2 million, had the Authority been forced to pay interest on the $705 million appropriation made by the Federal Government.

In addition, through TVA operation, the Federal Government lost all, and the state and local governments a part, of the taxes which would otherwise have been obtained, had the development been undertaken by privately-owned utilities. TVA has never paid more than 7.3 per cent of its gross revenue in taxes, while private utilities paid as much as 24.1 per cent.

Financial Results

Examining the financial results of TVA operations, Mr. Massue quoted its annual report for 1945 as revealing a net operating income of $18,606,000 a return of 4.8 per cent on the $391,000,000 (less depreciation reserves) which he said was the net investment in power facilities.

But according to Mr. Massue, when the true operating cost of TVA is considered, its operation is discovered to have resulted in a deficit during four of the last eight years, and a surplus in only four. The 1945 surplus of $9.3 million reported by TVA, he said, includes no provision for interest charges or payment of taxes, such as paid by privately-owned utilities.

Considering the cost of interest to the government, and the total of taxes lost to all governments, national and local, due to TVA replacing private utilities, the operation of TVA is found to have resulted, between 1938 and 1944, in annual deficits reaching as high as $25.9 million in 1942.

He also predicted even larger deficits in the postwar period, pointing out that three-quarters of the energy disposed of went into war production or other war uses in the last few years, and that TVA would have difficulty in disposing of its surplus power.

Predicted Industrial Growth Fails to Materialize

TVA's vaunted electric rates, although admittedly among the lowest in the United States, have not made the Tennessee Valley the industrial Garden of Eden forecast in 1933 by its hard-working propagandists, according to Mr. Massue. Comparing the principal manufacturing states on the basis of increased value of products added by manufacturing, per capita of population, for the year 1939, Mr. Massue showed that Connecticut led with $405 per capita, followed by New Jersey with $367, and Michigan with $343. Tennessee, the state most affected by TVA, added only $109 per capita.

Utilization of electricity for commercial and industrial purposes in 1939 in the state of Tennessee was as high as in most states of the Atlantic Seaboard and in the Great Lakes region, Mr. Massue said. "The availability in the Tennessee Valley of larger quantities of electric energy is not going to bring about the prosperity experienced in the Atlantic Seaboard or the Great Lakes Area," he added, pointing out that availability of raw materials, markets, labor and transportation are the determining factors in the location of most industries. Most industries which produce large employment are those requiring little electric energy, such as automobiles and automobile supplies.

"The development of the production of aluminum has resulted entirely from the cheap power available; it is not an industry which helps very much to increase the standard of living of any area, for it does not require a large amount of expert workmanship, or of the type which commands the highest wages," Mr. Massue said.

Individual Income in TVA States

Statistics on income received by individuals in states affected by TVA in the first seven years of its operation do not show much improvement, Mr. Massue said. In Tennessee, the income per capita in 1940 was only about 6 per cent higher than in 1929, despite extensive construction of dams and power plants in progress throughout the state. In Alabama, Georgia, Kentucky, and Mississippi, the income per capita in 1940 was less than at other times before the formation of TVA.

Yet in North Carolina, a state in which TVA did not sell one killowatt-hour, the 1940 income was the highest recorded, and about 20 per cent higher than in 1939, he stated.

Examining the extravagant claims made about large industrial development resulting from TVA operations, Mr. Massue pointed out that in Tennessee in 1939, as compared with 1929, wage earners had increased about 2.5 per cent, their earnings had dropped about 5 per cent, and the value of manufactures had actually decreased by $2.5 million. In Alabama, 1939 figures, as compared with 1929, show that the number of wage earners had decreased about 2.5 per cent, earnings dropped by $10 million, or 10 per cent, and manufacturing production increased about 2.5 per cent.

"Surely the increase in income received per capita throughout the states affected by the Tennessee Valley Authority does not warrant the claims made about the progress accomplished in the region. It is evident that such claims are more emotional than factual," Mr. Massue said.

"Whatever the growth during the war, it is not necessarily an indication of the permanent progress accomplished. In the end, what will really count is the gain that will be kept after all war activities have ceased," he concluded.

EEI Publications

A catalog of all EEI publications is available upon request to

EDISON ELECTRIC INSTITUTE
420 Lexington Avenue, New York

Public Benefits Through Using Existing Facilities For Marketing Power from Government Dams

By Hon. Ralph L. Carr
Former Governor of Colorado

Address before the Annual Meeting of the Edison Electric Institute, New York, N. Y., June 4, 1946

THIS discussion is deliberately limited to the question of the marketing of power from Government dams since it is in connection with this problem that the fundamental public policy difficulties arise. The mere building of Government dams and the installation of power generating facilities, while serious to you, in themselves should not constitute a threat to the stability of the electric utility industry. However, the policies and methods for marketing the power, which are still in a tentative and formative stage, may drastically affect the industry throughout the whole country.

A summary of the Government program for power dams will make clear the magnitude of the marketing problem. The country's present power capacity, excluding industrial plants, is about 50,000,000 kw, of which about 15,000,000 is water power. There are now about 40 hydro projects operated by agencies of the Federal Government with an aggregate capacity of approximately 4,500,000 kw. Either under way or contemplated for early construction, insofar as it can be estimated, are about 175 Federal hydro projects, with aggregate capacity of about 14,000,000 kw. Of this 14,000,000 kw more than half either is already under construction or else is authorized. Subsequent additions at these sites and supplementary plants in the same river systems are expected to add another 7,000,000 kw. These figures do not include Government owned steam generation plants, existing or proposed. The present Federal hydro program thus totals about 21,000,000 kw in addition to the 4,500,000 kw now in operation. The program will doubtless be expanded.

The figures given for the Government program exclude water power projects of irrigation districts, municipalities and State Authorities. While, generally, the same principles may apply to the marketing of power from State projects, it is simpler to confine the present discussion to Federal projects.

The immediate Federal program of 14,000,000 kw is spread rather uniformly over the country except in the northeastern states and in the states bordering on the Great Lakes. For that part of the country, excluding these states, the immediate Federal hydro program represents an increase of more than 60 per cent over present total generating capacity.

With the policies and programs for building multi-purpose dams, we are not here concerned, nor are we concerned in this discussion with the relative roles to be played by Federal and State agencies in this field.

The complicated considerations which have led to the predominance of Federal agencies in the development of the country's remaining water power have little real bearing upon the problem of how the power, once developed, should be marketed. The principal direct connection is the understandable, human ambition of the promoters of the Federal power projects to expand their jobs to cover the marketing also. Nonetheless there has been, and apparently there still is, a strong drive by Government agencies to build extensive transmission and distribution facilities, largely duplicating existing facilities, and to confine the sale of power so far as they can to particular classes of users. It is claimed, but I believe, incorrectly, that such a policy is called for, or at least permitted, by certain recent legislation.

Let us look for a moment at the broad aspects of this marketing problem. The dams and the power generation facilities are being built with taxpayers' money—money taken directly from taxes or else borrowed—for the repayment of which, principal and interest, the taxpayers are responsible. The investment risk on the funds thus invested in such development is the taxpayers' risk and it is a certainty that some of the projects will not pay out, even on the low rate of interest which the Government can secure with credit backed by the national taxing power.

Taxpayers are widespread. It seems fundamental that the benefits or advantages to be derived from this use of taxpayers' funds should in turn be given as widespread distribution as it is practicable to attain.

The cost of power from a multi-purpose project is of course largely a matter of arbitrary allocation of joint costs. Within wide limits the price to be charged for the power can be whatever the administrators see fit to make it. In setting up justification for a multi-purpose development it is usually represented that the power will be priced somewhat below the cost of power from alternative types of power development, and, hence, that public benefits will accrue in the form of lower rates to power users and consequently more liberal use of power will result. Sometimes, especially in regions of high fuel cost, the low-priced output from a project is represented as essential to the industrial development needed to build up a prosperous over-all economy in that region.

Assuredly this background of use of taxpayers' money at taxpayers' risk emphasizes the obligation, in simple equity, of following a marketing policy of such a nature that the potential benefits to individual power users and the incentives to new industrial development will be as widely distributed as possible. This point is emphasized now since I believe it to be fundamental in the solution of the whole problem. It will be discussed later.

Before going further into the policy aspects of this problem of marketing Government power, may I become an engineer just long enough to point out some underlying physical factors, which, clearly, are non-controversial. Marketing of this hydro power involves two phases, *first* the firming up, by use of steam or other means, of the irregular supply of hydro power from Government dams; and *second*, the delivery of the power over transmission and distribution facilities to points of use.

The firming up of hydro power, al-

ways a major problem, is especially difficult in cases of multi-purpose dams. With single-purpose power developments the reservoir storage is used so far as it goes to equalize river flow and also to stabilize power output. In the case of dams for impounding irrigation supplies, or for regulating navigation facilities, the water releases and the development of power are dictated and determined mainly by unpredictable seasonal irrigation requirements and navigation needs, and these controlling factors, be it said, by no means correspond to power needs. With flood control dams much of the reservoir capacity must be kept empty and hence is useless for carrying stored water through into dry seasons to assure irrigation supplies and to equalize power output. As a consequence the available power output from true multi-purpose dams is highly variable as between seasons and as between wet and dry years.

Most of the power available from multi-purpose dams is not commercially usable power; it is only part of the raw materials from which commercially usable power can be made. Unless a major part of the potential water power at a dam is to be wasted, the seasonal power deficiencies and the dry year deficiencies must be made up from supplementary sources. Except in the Northwest, where fuel is very expensive and conditions are unusually favorable for developing hydro plants with large storage reservoirs, the supplementary source is usually steam.

If the Government power is to be marketed through the facilities of existing power systems, there should be close coordination in the operation of the new government generating facilities and of the existing privately owned generating facilities. Where, as will usually be the case, the existing systems have steam plants or single-purpose storage hydro plants with aggregate capacity as large as, or, larger than, the Government hydro, this firming up can be done by off peak use of the existing steam plants or by changing the seasonal schedules of the storage hydro plants. The result will be that little, if anything, in the way of additional generating facilities will be required to convert reasonable proportion of the erratic power output of the Government dams into usable firm power.

On the other hand, if the Government dams are to be operated largely independently, with separate transmission systems, and separate markets, additional facilities must be installed to supplement the hydro in dry seasons and dry years. Such additional facilities, steam or single-purpose storage hydro, will not be needed during periods of good river flow or high river flow and will represent a direct duplication of investment in generating facilities. If, as would be true in most cases, the firming up of independently operated Government hydro plants were done with steam, the steam capacity would amount probably to one-third or one-half of the hydro capacity. This is definitely a wasteful duplication which could be avoided by pooling the Government hydro plants with existing plants. A further saving would arise from avoidance of transmission facilities for connecting the Government steam plants.

Illustrating this, the output of the Government's Colorado River plants, Boulder and Parker, has been firmed up by large amounts of steam capacity in the Los Angeles area and in Arizona. The output of the Bonneville-Coulee plants on the Columbia River was largely firmed during the war by coordinated operation with the single-purpose storage hydro plants and steam plants of the adjoining privately owned and municipally owned utility systems. While the TVA output on the Tennessee River was firmed by a combination of its own steam plants, equal to 25 per cent of its hydro capacity, special storage developments and heavy purchases of off-peak steam from adjoining utility systems were also needed.

The other phase of marketing power from Government dams, that of delivery to points of use, also brings up important issues of engineering economics. Points of use are widely scattered. Sources of hydro power are concentrated. Power is delivered from generating stations to points of use by a branching network of transmission circuits, distribution circuits and substations. The cost of this network of facilities depends, in part, of course, upon the amount of power to be delivered and upon the distances from the power sources. But, also, it depends in large part upon the service area to be covered. Since a major part of transmission and distribution cost is for area coverage, it follows that two systems delivering the same aggregate amount of power over the same area must cost much more than a single system capable of doing the whole job. Except for the direct connections to new dams, the additional power from Government projects usually can be distributed over existing systems with added reinforcements in only parts of the systems. The incremental cost of connecting into new dams and of making internal reinforcements from time to time, as needed, is likely to represent only a small part of the cost of building a new and separate transmission and distribution system.

Facilities for transmitting and distributing power are expensive. As a country-wide average their cost is more than one and a half times the cost of generation facilities. Even in hydro systems the transmission and distribution facilities usually cost more than the power plants. Accordingly, the saving of a substantial portion of transmission and distribution costs is a saving of major importance.

Considerable time has been consumed in explaining that the marketing of power from Government dams costs less if done through the facilities of existing systems than if done independently, in whole or part, through Government owned facilities or through facilities of quasi-public local agencies sponsored by the Government. While such independent facilities might be subsidized by risk-free money and substantial exemption from taxation, the basic economies effected in capital cost and operating expenses through coordination with the facilities of existing systems are so large as to assure lower aggregate costs of power delivered to the users. In addition, tax revenues would be preserved.

Furthermore, other economic benefits are to be expected, both in cost and in quality of service, from having the marketing of this power carried out by organizations with adequate resources of engineering and technical skill, of farsighted management and of acumen and experience in selling to consumers the benefits to be secured from more extensive use of electric service. Such an organization is usually an essential part of every established utility company. A local Government organization may not have it. And a local quasi-public system, such as a public utility district, can scarcely be expected to have it.

Let us now return to the question of obtaining not only an economical, but a wide distribution of this Government produced power. In the basic legislation this purpose is clear. For instance, in the Flood Control Act of 1944, the pol-

icy as to disposal is "in such manner as to encourage the *most widespread use* thereof at the lowest possible rates to consumers consistent with sound business principles." This declaration of underlying policy emphasizes both widespread use and economy of cost, both of which are securable only through coordination with existing facilities and systems.

There is, however, a detailed provision in the Flood Control Act of 1944, and earlier in the TVA, Bonneville and Fort Peck Acts, which in some degree is inconsistent with this policy in that a preference is given, as to use of power from Government dams, to public bodies and cooperatives. Even allowing that this is a preference only as to availability and not as to price, it is difficult to comprehend the reasoning underlying such a provision. The benefits to be derived from this power are paid for and supported by the taxpayers—meaning directly and indirectly all of the people. In fairness there seems to be no reason why the Government, in dispensing benefits so created, should give first choice to a group of power users, who, by their election, or by the mere accident of location, purchase their power service from a public body or a cooperative organization, in discrimination against other users less happily located and purchasing their power service from a business enterprise with security holders. The provision is unfortunate also in that it is being used as an excuse for Government building of independent transmission facilities and steam stations otherwise unnecessary, in order that service may be delivered directly to the preference classes.

It is to be hoped that when the significance of this provision becomes more widely understood, it will be repealed.

While we have been told, as a defense of this provision, that it was written to assure that benefits gained from the use of public funds would go to consumers and not to the stockholders of power companies, I cannot accept that defense as being offered in good faith. Electric utilities, because of the nature of their business and facilities, are subject to the strictest regulation by local authorities, usually State Utility Commissions. We all know from wide observation that present day Utility Commissions are diligent and alert. To say that they are not competent to enforce a requirement that any benefits from Government produced power marketed over existing systems shall be passed on to consumers is a wholly unwarranted attack on such Utility Commissions and on State administrations generally.

However, in most cases, this provision, inequitable and unwise though it is, need not have much practical bearing on the question of what facilities are to be used for marketing the power. So long as the provision remains in the law, Government officials quite properly will endeavor to enforce it. Usually, in a region where Government dams are being built, there will be substantially more Government power available than existing public bodies and cooperatives can use or may wish to use; hence, after their needs are met some of the power will usually be left over for distribution to other power users. Responsible Government officials have recently disclaimed any intention to proselyte in favor of additional public agencies and cooperatives in the power utility field. Therefore there is likely to continue to be more than ample power to supply the needs of these preference classes. As to the preference classes there remains only the problem of delivering the power to them. As to the remainder of the Government power and the presumed savings therefrom, they should be distributed as widely as practicable among other power users.

The Government power can be delivered most economically to these preference classes, as well as to other power users, by making a maximum practicable use of the facilities of existing systems. Independent operation with duplication of facilities and loss of operating coordination can more than wipe out all of the presumed savings, even for the preference classes of users. From the viewpoint of our subject, it may be immaterial who provides the direct connections to the new dams, but it is highly material that there be no unnecessary duplication of existing transmission facilities and that new transmission facilities be coordinated in planning and in operating with existing facilities.

Sale of Government generated power over existing facilities to the preference classes might be carried out by establishing resale rates which are sufficiently above firm power bus bar rates to cover adequate delivery costs and losses, or it might be carried out by other arrangements. We know that such other arrangements have undesirable aspects and that they are discriminatory as against other power users. However, they would seem to constitute a lesser evil than the wasteful duplication of facilities set up to permit direct service to these preference classes, should Government administrators consider such duplication a necessary or permissible alternative under applicable laws. It would seem, however, both inequitable and inexpedient to enter into such an arrangement with respect of any other power users than the preference classes under Federal statutes. Except where necessary to comply with Federal laws, such arrangements in some cases might constitute discrimination under State laws.

With respect to the general subject of preferred classes of power users I may refer parenthetically to my belief that special terms may properly be given to rural electrification projects—not because the ultimate users are members of cooperatives—but, because they are farmers. Improvement of living conditions and increase in working efficiency in farming areas are a matter of concern to the public generally and to residents of adjacent non-farm areas in particular. However, this preference presently accorded to cooperatives under the Federal acts is not at all necessary in order to secure special benefits for rural electrification. Utility companies are now making both retail and wholesale rates for rural service on what approaches an increment out-of-pocket basis. These rates are lower than for comparable service to other types of customers, and Utility Commissions generally are approving and encouraging such rates.

We have heard the claim that the Federal Government must protect its water power investments by the ownership of the transmission lines from the dams to market centers, even at the expense of increased costs to users, because otherwise in the future the Government will be at the mercy of the owners of these transmission lines. The argument is not convincing. Congress has ample power to protect against such hold-up tactics, should they ever threaten.

In summary, there are outstanding public benefits to be secured through marketing of power from Government dams through the use of the facilities of existing power systems. This is true either with the facilities as they now exist, or, as they will be developed in the future with the natural development of the systems. And it is likewise true whether such existing systems be owned

by utility companies, municipalities or State authorities, or by combinations thereof. Substantial economic benefits are assured through the avoidance of investment in unnecessary and duplicating facilities, through the full and efficient utilization of the Government power through coordinated operation, and through corresponding savings in operating expenses. The realization of these economic benefits means lower costs to power users, and incidentally, higher tax revenues. Even more important, perhaps, are the benefits attainable through wide distribution of the presumably low priced power from Government dams, with consequent more widespread stimulus to increased use of power by all users and increased incentives for industrial development throughout the whole region. State regulatory authorities are wholly competent to see to it that all savings are passed on to power users.

The alternative to the use of the facilities of existing systems is either more Government owned, or else more Government-sponsored and subsidized, transmission and distribution systems, with these systems gradually taking over the whole power load. This would be the case not merely in the preference classes, but also in other classes especially where larger industrial loads are served. Government encroachment and subsidized competition in this field, with continuing adverse propaganda and political attacks against utility companies, constitute a direct threat to the future of private enterprise in the electric utility business. General supersession of private enterprise in utility service in the regions where Government dams are now being located would all too rapidly spread to the remainder of the country.

It is difficult to believe that the Congress intended to force or encourage uneconomic and wasteful methods of marketing the power developed at the dams for which it has appropriated funds. Surely the Congress does not approve of any plan to turn this power into a device which will destroy private enterprise in the electric utility field. I fear there has been in the recent past, too much reason for suspecting that the language of the statutes is being distorted to establish excuses for deliberate evasion of cooperation.

What we should soon see is the pleasing spectacle of all Government agencies having jurisdiction taking the lead in bringing together the utility companies, the municipal power systems, the State power systems and the REA's into a fully cooperative program so as to assure full and effective utilization of the power developed to avoid duplication and waste, to provide adequate facilities for the most widespread distribution of power from all sources to all types of users, to reduce power costs, to encourage and assist increasing power use, and, generally, to make electric service a powerful agent for the welfare of every region served.

Rural Electrification

(*Continued from page* 189)

panies and amplify them to give the general public more and better information on the fine job that our companies have done in extending service to the farmers. During the '20s, our companies did the pioneering in rural electrification. We were responsible for the development of new standards of construction and new lines of farm machinery suitable for electric drive. We have built hundreds of thousands of miles of electric lines. Today we furnish retail electric service to 60 per cent of all farms served in this country and supply wholesale a majority of the electric power sold retail by the REA co-ops. Our record in rural electric development is good and is worth talking about. We do not wish to gain any position in the public mind that is not deserved, but unless we are willing to do something about this publicity, we should not be surprised when we find that the public thinks we have done little and the REA co-ops are really responsible for rural electrification.

Practically every city and village in the United States now has 24-hour electric service, and when the electric lines are built to all the farms of this country, we can truly say that electric service is available to everyone throughout the entire length and breadth of our land. The farm electric lines will not only carry electric service to the farmers, but will also make it available to the country schoolhouse, church, country store, garage, creameries, small crossroad settlements, and in fact to everyone living in the country.

The operating companies of the United States started Rural Electrification; they have developed it at a reasonable speed. Let us now do the things necessary to carry it on to an early and successful conclusion.

Morgan Appointed EEI Assistant Managing Director

A. B. MORGAN has been appointed Assistant Managing Director of the Edison Electric Institute, according to an announcement by Col. H. S. Bennion, Vice-President and Managing Director of the Institute.

A. B. MORGAN

Mr. Morgan has been the Rate and Power Consultant for EEI, heading both the Rate and General Service Departments. In his new position, he will assist Col. Bennion in the supervision of the Institute's operations, and will also continue his present responsibilities.

A graduate of Massachusetts Institute of Technology, Mr. Morgan joined the National Electric Light Association, predecessor of EEI, in 1927 as an assistant engineer. He specialized in Codes and Standards activities, representing the electric light and power group on committees of the American Standards Association.

Mr. Morgan, during this period, also organized and conducted the first industry investigation of load characteristics of oil burners, and a comprehensive study of water heater load characteristics.

He was promoted to Engineer in 1933, and later became Rate and Power Consultant. He has acted as staff representative of the Industrial Power, Rate Research and Postwar Planning Committees.

Mr. Morgan is a member of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. He has served for the past fifteen years on the ASME Oil Engine Power Cost Committee, and is recognized as an authority in this field.

Developments in Rural Telephone Service of Interest to Electric Utilities

By A. E. Silver
Ebasco Services Incorporated

Address before the Annual Meeting of the Edison Electric Institute, New York, N. Y., June 3, 1946.

IT will be remembered that in 1922 the now widely accepted Edison Electric Institute - Bell System "Principles and Practices" were adopted and broadcast to the operating units of both industries. To my mind, the principle among these that has proved the most constructive is, in essence, Seek the best Engineering Solution. Adherence to that principle, more than any other one thing, I believe, is responsible for the remarkable advance in measures of coordinating facilities of the two industries.

Having accepted this guide in dealing with situations that have arisen in the twenty-four years since 1922, I would find it difficult, personally, to describe the present status of developments in rural telephone service, other than from the approach of developing the best engineering solution in the broad problem of extending both telephone and power services just as widely as practicable in the rural areas. Therefore, in dealing with the subject assigned me, I shall endeavor to present the engineering picture, principally as it has evolved through the joint activities of the power and telephone interests, under the sponsorship of the Edison Electric Institute-Bell Telephone System Joint Committee on Plant Coordination.

Present Extent of Service to the Farms

To give some conception of present overall opportunities for joint service undertakings by power and telephone industries, a few statistics are offered. These figures are rounded out from recent estimates.

Total Farms	6,000,000
Farms without power service	3,000,000
Farms available for power service (excluding those without buildings, buildings unoccupied, and widely isolated)	2,500,000
Of these, existing power lines, reach	900,000
and beyond reach of existing lines	1,600,000
Power Utilities' 3-year program, extension to farms	560,000
Farms without telephone service	4,000,000
Of these, existing telephone lines reach,	3,000,000
and beyond reach of existing lines	1,000,000
Bell System 3-year extension program provides for new rural customers	1,000,000
which includes farms	700,000

In these figures, "reach" means within one-half mile for telephone and within one-quarter mile for power.

Rapid extension of power and telephone services to the now unserved farms, with sound economic outcome, calls for physical facilities and their operation with maximum overall economy, that is, demands the best overall engineering solution.

Background of Urban Experience

Let's look briefly at the background of experience in closely coordinating power and telephone overhead circuits in urban areas. Common occupancy of poles began in a small way something like forty years ago, when the accepted guide was separation of facilities. For over a decade, progress was gradual, with separation continuing the predominant guide. By 1917, there had matured a realization that in built-up areas with the two services destined for the same users, the policy of maintaining separate facilities was leading to a situation of impracticability. It had become evident that along the same street, with a multiplicity of services, wires could be more systematically coordinated physically on one line of poles. It was at that juncture that National Electric Light Association-Bell Telephone System organized deliberations got under way. About coincident with issuance of the officially adopted Principles and Practices in 1922, a research program was initiated for developing technical knowledge and measures of coordinating telephone and power facilities in close proximity with each other. Progress soon rendered conventional, practices for close proximity telephone coordination with power distribution primary circuits of the 2300/4000-volt class.

Mutually satisfactory joint use at the higher distribution voltages has awaited rather recent advances in the art of coordination. Now joint use at distribution voltages up to 15 kv is going ahead actively in many urban areas.

A thoughtful appraisal looking toward fully coordinated power and telephone service facilities in the rural areas shows the same basic principles applying as in the urban areas, but with widely different factor values.

In town, high density of power customers requires frequent spacing of poles, while for rural, customer density is a minor factor in determining pole spacing. Load densities are low, so that conductors are selected for strength more than for conductivity. This comparison also is broadly true for rural telephone lines. The designing of both farm power and telephone lines therefore predominantly is a problem of providing mechanical ruggedness at low cost. Quite a number of years ago, power companies began using small high-strength conductors on poles spaced up to 600 feet or more. Somewhat later, the telephone companies initiated use of high-strength wire and it is being applied in similar departures from urban practice.

In providing electrical safety to customers, the basic principle is the same—rural or urban. It is an adequate grounding medium in such close proximity to both power and telephone utilization devices as to prevent dangerous over-potential on any of these devices. In urban areas, the availability of water-pipe systems, with cooperation of the owners, has provided a dependable safety grounding medium for both power and telephone. In rural areas, although equivalent water-pipe systems usually are lacking, the power-circuit multi-grounded-neutral conductor has become a thoroughly effective medium for protective grounding.

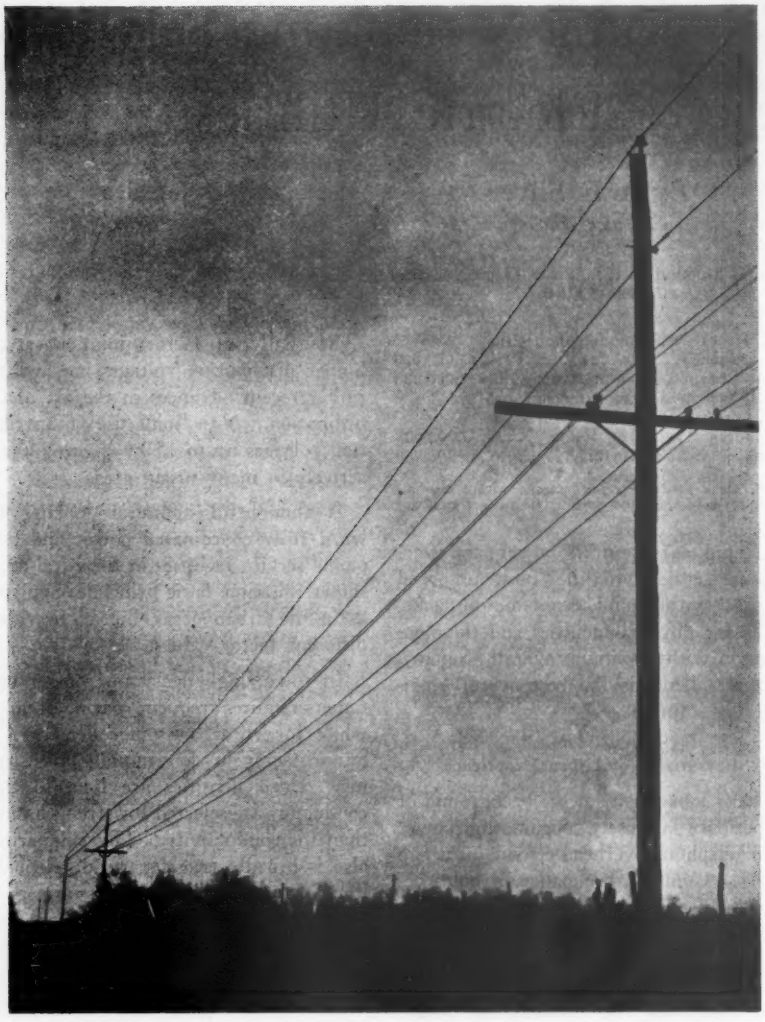


Fig. 1—Typical stretch of Selma open-wire joint-use Farm line.

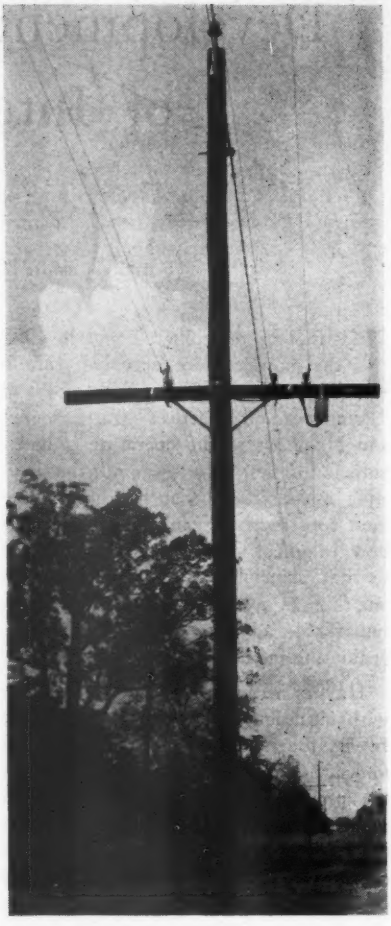


Fig. 2—Typical pole with telephone circuits, including transposition protectors and drainage unit.

Coordinated Facilities for Farm Service

In looking toward the best engineering solution, that is, minimum expenditure of manpower and money in rendering both power and telephone services to the farms, it is natural, to think over the elements wherein there is duplication. In the construction of separate physical facilities, duplication is found in rights-of-way, clearing rights-of-way, poles and other supports, and line and service wires. In their operation, there is duplication in manpower and equipment for maintenance—including tree trimming and for service activities, without mention of items of similarity on the business front.

We all recognize, of course, that with the respective services, techniques of construction and of operation have been built up along quite different patterns. Early elimination of all evident duplication is not being proposed; however, these possibilities may well be kept in mind for future consideration.

Power and telephone engineers do recognize immediate opportunity for avoiding duplication in extending physical facilities. The Edison Electric Institute-Bell Telephone System Joint Committee on Plant Coordination is furthering this end. Two subcommittees are at work studying specific ways of accomplishment. One is:

Subcommittee on Joint Use of Poles for Rural Power and Telephone Circuits.
EEI Chairman—H. J. Scholz, Commonwealth & Southern Corp., Birmingham, Ala.
Bell System Chairman—J. W. Campbell, American Telephone & Telegraph Company, New York City.

The other is:

Joint Subcommittee on Rural Telephone Service by Carrier on Power Circuits.
EEI Chairman—Lee Cook, Ebasco Services Incorporated, New York City.
Bell System Chairman—F. A. Cowan, American Telephone & Telegraph Company, New York City.

Developments in the fields being studied by these two subcommittees are of timely interest. I shall describe the high spots of what is being accomplished.

Joint Use of Poles in Long-Span Construction

Problems of joint occupancy of open-wire power and telephone circuits in long-span farm-type construction have been mutually discussed from time to time for more than a decade. However, it is only quite recently that Bell System engineers have considered they had at hand a type of wire and other devices essential to safe and successful coordination. The first trial of such construction came to fruition in 1945 through the initiative of Commonwealth & Southern Corporation and Southern Bell Tele-

phone Company. This followed a survey of low customer density areas, seeking ways of extending both services to more people. These two companies selected for this trial an existing sixteen-mile farm power line of Alabama Power Company, near Selma, Alabama. This initial installation has been quite thoroughly described—including references in *Electrical World* of November 24, 1945, and the November, 1945, EDISON ELECTRIC INSTITUTE BULLETIN. The more essential features of the construction will be mentioned, with particular reference to coordination from the telephone point of view.

This power line was of typical farm type, 7200-volt single-phase multi-grounded neutral, on 35-foot Class 7 poles, No. 4 ACSR conductor on pole-top pin and for neutral below. This line of sixteen miles comprised 197 poles. The joint construction was laid out to provide National Electrical Safety Code clearances and strength under medium loading. Based on telephone subscriber prospects, the joint line was planned to provide ultimately for four telephone circuits for three miles, thence two circuits for 7.5 miles with one circuit for the remaining 5.5 miles. Standard 10-pin, 6-pin and 4-pin telephone crossarms were installed in these respective sections. The telephone wire used was No. 12 Bwg (Bell System 109) high-strength steel.

Change-out of twenty-one, or 10.7 per cent, of the poles was required to provide telephone wire clearance above ground and at crossings over roadways, also some additional guying of poles. In the joint line, pole spacing averaged 435 feet, with eight spans in excess of 457 feet and one of 570 feet. It is of interest that the Bell Telephone Laboratories now has under development a higher strength steel telephone wire No. 10 Bwg (Bell System 134) suitable for still longer average spans for heavier loading.

For a 7200-volt single-phase-to-neutral power circuit, National Electrical Safety Code requires minimum operation above telephone wires, at 60 F and no wind, of 30 inches in the span and 40 inches at the support. It was felt that for the present, there should be some additional separation between power and telephone wires for working safety while the telephone wires were being strung and for repair and maintenance work. A line-of-sight clearance was established, therefore, being the separation between the power conductor at its nearest point in the span and the line-of-sight between the points of attachment of the telephone conductors.

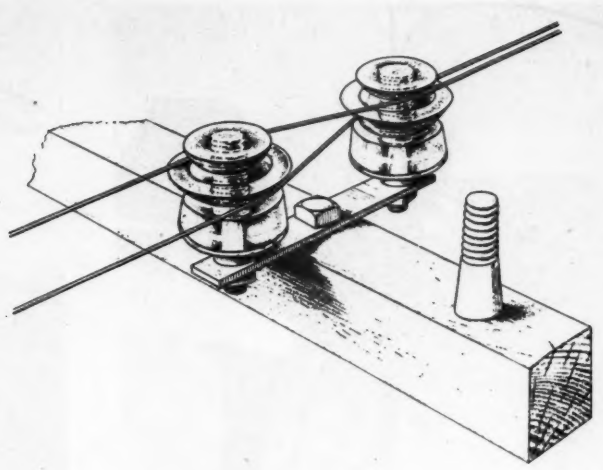


Fig. 3—R-1 Telephone Transposition and Bracket.

For safety, there was applied a protector gap (Bell System 99A) developed by the Bell Laboratories for use on open-wire circuits in close proximity to power circuits in excess of 5000 volts. This protector, connected to the power neutral, provides a low-impedance path to ground to insure fast de-energization of the power circuit in case of contact.

Satisfactory electrical coordination was secured by several specific devices, including:

A new drainage unit developed by Bell Laboratories to reduce static voltage induced on the telephone wires.

A new design transposition with new transposition bracket.

A telephone ringer circuit provided with cold-cathode tube for effecting circuit balance.

From experience and calculation, it was predicted that the telephone circuit would be subject to objectionable induced potentials. The new drainage unit, with midpoint tap grounded to the power neutral conductor, was installed in each telephone circuit at intervals of about two and one-half miles. Voltage readings showed the induced potential reduced to a satisfactory value of about 80 volts under open circuit, and to only 11 volts with the circuit connected through to the central office.

The Bell Laboratories recently has developed a simplified system of transposition, designated type R-1, especially suited to rural open-wire joint construction. It provides for transposing each pair of wires at every second pole throughout, however, staggered so that transpositions on adjacent pairs fall on different poles. This design utilizes a recently developed tandem transposition bracket having practically no effect on the overall length of conductor, so that transposition can be inserted easily after the wire is pulled to regular tension.

Figure 1 shows typical spans of the joint-use line. Figure 2 shows typical arrangement for a pole with transposition, drainage coil and protector gaps. Figure 3 shows the Type R-1 transposition and bracket.

Results on the Selma installation indicate that with the power circuits normal and with good telephone circuit balance, the induced telephone noise is low and compares very favorably with average urban telephone service. Except for a few difficulties, expected with new devices, the telephone circuits on this joint line at Selma have performed satisfactorily. Continued attention to improving details and further simplification should bring increased economies in construction and in operation.

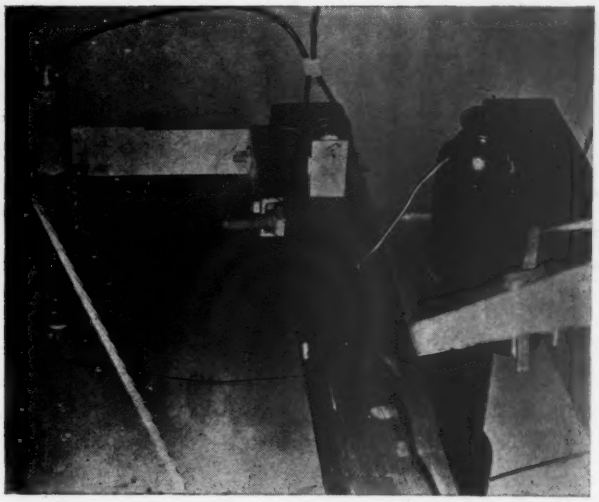


Fig. 4—Telephone Coupling Capacitor Mounted on Power Crossarm.

Fig. 5—Carrier Telephone Common Terminal in Test Hut.

The degree of success realized in this Selma installation augurs well for satisfactory results with other companies and in other sections of the country.

Very recently a Tentative Specification, prepared by the Joint Subcommittee, has been made available as a construction guide for long-span joint construction.

Carrier Telephone Service on Farm Power Circuits

Telephony by the carrier method is not new, having been in practical use for about thirty years. Use of carrier on power transmission lines began about twenty years ago. About ten years ago, thought was given to adapting the carrier system for telephone service over rural power distribution circuits, and Bell Laboratories took up a definite study of this in 1938. The work was shelved during the war emergency, but now has been actively reinstated.

Compared to the conventional telephone, the terminal sending and receiving facilities of the carrier system are relatively complex and expensive. The economic promise of carrier, therefore, is for service to widely scattered farms where the cost of providing conventional telephone service over open-wire circuits is relatively high per subscriber. The problem has been to develop simple and sturdy carrier facilities suited to the prevailing single-phase farm power circuit; however, development for its application on three-phase power circuits is under way. This carrier application is in the 150-500 kilocycle band.

The first essential is a satisfactory capacitor for coupling telephone carrier current to the power wire in the vicinity of the central office and to take off the carrier at each indivdual subscriber service. Such a capacitor, of somewhat the outward appearance of a 7200-volt pole-type lightning arrester, is available.

Losses in the strength of the carrier signal increase rapidly as it spreads outward into the branches of the typical rural power circuit, making it essential to block this carrier out of each section of power circuit where telephone service is not required. Choke coils have been developed which block the passage of carrier frequencies but readily pass the power frequencies.

At the present time, two trial installations of carrier telephone are in use—one at Selma, Alabama, on the lines of Alabama Power Company, and the other at Jonesboro, Arkansas, on the lines of Craighead Electric Cooperative.

The carrier trial installation at Selma is by Alabama Power Company and Southern Bell Telephone Company, utilizing the same sixteen-mile section of rural line as the trial of joint use with open-wire telephone circuits. A voice-frequency circuit extends from the central office over a conventional open-wire and cable circuit to a common-carrier terminal which converts to carrier frequency. The carrier side of the terminal is connected to the power primary wire through a coupling capacitor. This common terminal is intended for pole mounting but for convenience observation during trials was installed in a hut located close to a power pole. Figure 4 is a closeup of the carrier-coupling capacitor mounted on crossarm.

This common carrier terminal includes a transmitter and two receivers, employs six vacuum tubes and requires 120-volt 60-cycle power. It includes relays and associated equipment for ringing out over the carrier circuit and signaling from carrier subscriber stations to the central office. Figure 5 shows the common carrier terminal in test hut, while Figure 6 shows it close up.

For each subscriber, the terminal installation is somewhat more simple, the carrier current being taken off the pri-

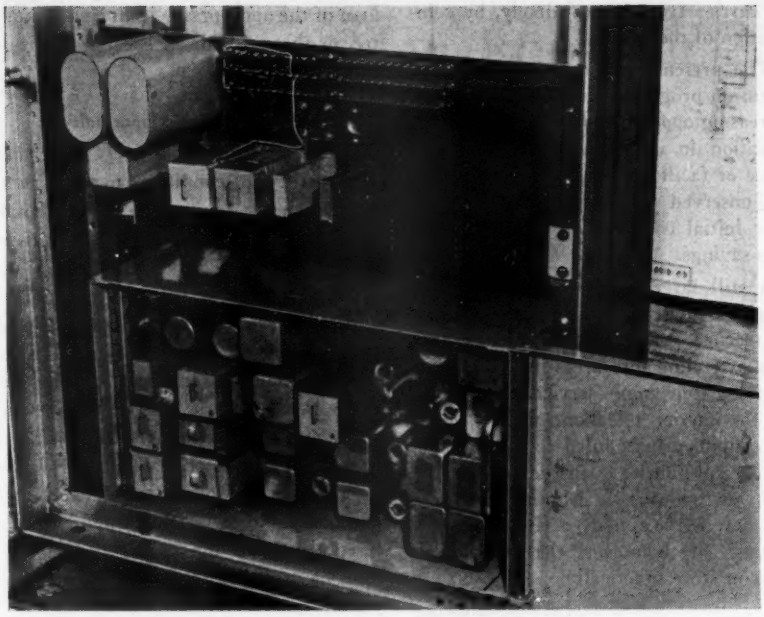


Fig. 6—Close-up of Carrier Telephone Common Terminal.

mary power conductor through an identical coupling capacitor, thence over service-drop wire to the subscriber set in the building. This is quite similar in manner to the transformer and service drop used for power service. Figure 7 is typical of subscriber carrier service connection on the pole. Figure 8 shows equipment used for the carrier subscriber set. This subscriber set includes four vacuum tubes mounted in a wall box and connected to a combination telephone instrument similar to the latest type conventional telephone. Power for this set is obtained from the 120-volt house wiring. Power consumption during the standby or non-talking condition is in the order of 7 watts, but increases somewhat when the set is in use. At Selma, rural telephone service is manual and the operators handle calls to and from carrier subscribers exactly as they do over the wire circuits.

The trial carrier system so far has given satisfactory service and valuable experience is being secured in its operation and maintenance. Development work is being continued for further simplification, reliability and economy.

It is too early to predict the extent to which the carrier system ultimately will be applied in rural areas, but already frequent cases have been found where its use promises economic advantage as compared with other methods of extending telephone service. It is an index of Bell System expectations of carrier acceptance, that present plans provide for the apparatus to be in very substantial quantity production during the last half of 1946. Rural Power Cooperatives will probably participate actively in utilizing this equipment.

The Bell System has announced that it will extend to manufacturers in this country a royalty-free license under Bell System patents to make rural carrier apparatus, subject to the sole condition that the manufacturer extend similar rights

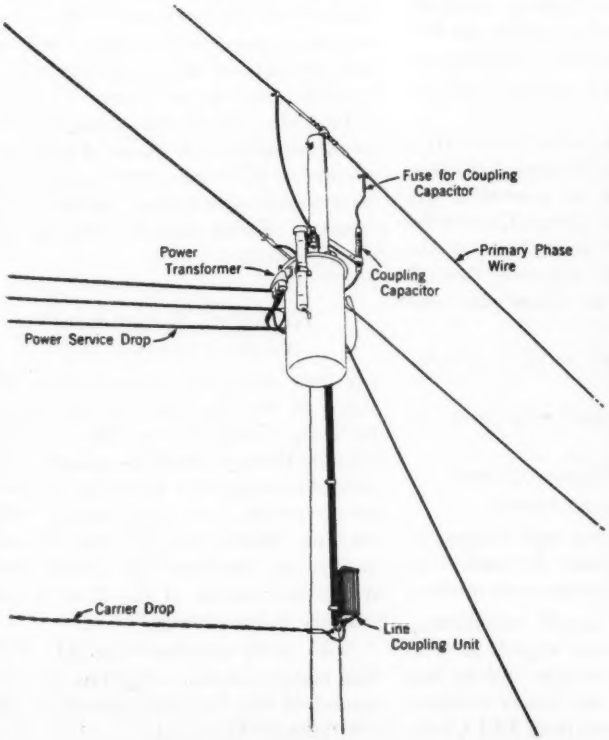


Fig. 7—Left—Typical Pole Arrangement with Carrier Telephone Subscriber Service.

Fig. 8—Above—Carrier Telephone Subscriber Set.

to the Bell System. This, coupled with the announced availability of equipment of Bell System manufacture, will make it possible for independent telephone companies and cooperative telephone groups to utilize carrier for rural service.

The Selma, Alabama, open-wire joint-use and carrier telephone trial installations had created much local interest in the Southeast. In response, under sponsorship of the respective Joint Subcommittee Chairmen, a group of operating company representatives visited the installations. Promptly following this visit their various aspects were described and discussed in a symposium at recent March meeting of Southeastern Electric Exchange in Birmingham. The knowledge acquired has led to the undertaking of several additional trial installations in the area.

The carrier telephone on farm power circuits does not have the extensive background of urban experience of the open-wire joint use. While there remains considerable working out of technical details, particularly as concerns choke coils and other devices for adapting the power circuit, and the development of operating practices, it does not appear that this will be particularly difficult or require a prolonged period. It will take experience from a reasonable number of specific installations to appraise costs with assurance and to determine how these costs should be allocated and several such installations are now being worked out. The cost and other burdens to a power company of trial installations are slight, which makes it quite favorable to proceed at once without firm commitment, and develop working agreement for expansion of the practice as familiarity matures. I am certain that the Bell System people stand ready to carry their full share of responsibility in this carrier undertaking.

Engineering Aspects—Looking Ahead

The farming public will soon require power and telephone service coverage to a high degree of saturation. Accomplishment calls for supply methods planned to yield maximum overall economy—in other words, methods directed to the best engineering solution. Already field demonstrations have shown the technical practicability of rendering power and telephone service in the farm areas by joint facilities of either the openwire or the carrier type, or very likely, by combination of the two.

The present very active farm power extension programs are bringing steadily decreasing opportunity for telephone participation in design coordinated in advance of facilities being built in presenting unserved territory. Modifications after initial construction, of course, reduce savings.

A still larger number of prospective telephone subscribers, it is believed, can be reached over existing rural power lines extending into areas not at present receiving telephone service. Especially for the carrier telephone project, with the equipment scheduled to be available in very substantial quantities within the next few months, it is clearly evident that now is the time to actively take advantage of whatever the application holds in store practically.

Because of Bell Telephone prominence in the industry, it sometimes may be overlooked that approximately half the present rural telephones in this country are supplied by the independent companies and cooperatives. While, doubtless, Bell System will continue the initiative in furthering facilities for jointly supplying rural power and telephone service. these other groups constitute a substantial part of the potentialities from the power-industry angle. With carrier telephone equipment developments available to these groups, as announced by the Bell System, it would seem that independents' participation should be expected and encouraged.

The present stage is that of perfecting technical details and developing the facts for sound appraisal of economies and other benefits. The Edison Electric Institute-Bell System active joint studies are directed to this objective, through the development of knowledge and guides for:

1. Providing both services at minimum investment.
2. Efficient operating procedures and practices.
3. Sharing benefits accomplished.
4. Contractual arrangements.

Pending completion and issuing of such guides, the Joint Subcommittees stand ready to offer interim information.

In approaching specific installations, negotiations, of course should be with your local telephone people. Advice that may be desired by any power company can readily be secured from EEI Chairman of the appropriate Joint Subcommittee, or through Edison Electric Institute Headquarters.

The Immediate Opportunity

It is opportune to actively undertake joint surveys of conditions in those rural areas seeming to promise benefit from cooperative procedure in extending power and telephone services. Just at the present stage, it is believed, a company will make best progress by starting with the working out of a trial installation. This procedure is neither difficult nor costly, so long as it is dealt with tentatively and for reaching a sound basis for subsequent expansion. The more widely distributed and prompt the experience gathered from these trials, the more representative and the sooner can conclusions be drawn for full economic participation.

In these times of carrying on under pressure from accumulations of deferred work, labor holidays, material shortages, and such, the natural reaction to such an undertaking is to defer. It is easier to postpone active attention until others have worked out the answers. A promise of investment differential as against separate facilities, of only a modest number of dollars per mile of line, may not in itself be a strong stimulus. The importance of prompt attention is reflected in the opportunity for intangible benefits well beyond any which can at first be counted in dollars and cents.

In closing, may I counsel that because of the importance of the rural situation, executives will find timely concern in joint power and telephone services to the farms as offering mutual public and industry benefits.

Kellogg's Retirement

(*Continued from page* 190)

tric light and power systems in the nation. In the war years he also guided the early destiny of the Office of War Utilities through which the industry supplied the nation with electricity in quantity never before so vitally needed. His untiring efforts brought him renown among his thousands of friends both within and outside of the third largest industry in the country."

Now at the retirement age, Mr. Kellogg plans to become a full-time farmer. instead of the "weekend variety" at his plantation in Maryland.

A Utility Man Looks at Atomic Energy

By Dr. J. C. Parker

Vice President, Consolidated Edison Co. of N. Y., Inc.

Address before the Annual Meeting of the Edison Electric Institute, New York, N. Y., June 3, 1946

ANY present discussion of the power possibilities of atomic energy is bound either to be hypothetical or, if conclusive in its statements, to be well in advance of the facts and probably wrong. None-the-less the interest, spontaneously generated and fomented by popular discussion, compels some kind of speculative preview.

The present speaker has complained of the unscientific processes of some scientists who, disregarding the importance of other branches of human experience and expertness, have, as it seemed, a bit too blithely made excathedra declarations as to what would be accomplished in the world of practical affairs and when. To avoid coming into the same condemnation, therefore, your reporter freely acknowledges that he is not able to appraise the fundamental scientific possibilities, to fix dates or quantitatively to estimate advantages and difficulties. The present remarks then should be regarded as in a sense a thinking aloud by a non-expert somewhat acquainted with the realities of the electric light and power business. For the sake of simplicity in expression he will have to indulge in certain generalizations to which, however, there will be exceptions which time does not admit of developing in detail.

While there are strong indicants that great peacetime results will flow from the development of a new technique, it will be desirable to begin by an attempt to eliminate some of the exaggeration that has come into popular expressions and which easily may deter sound development.

"Power Starved World" Picture Dismissed

The first of these exaggerations is in the picture set up that atomic energy will supply the needs of a hitherto power starved world. The difficulty is not in the representation that vast amounts of energy are available from nuclear processes but rather in the implication that heretofore there have been serious physical limitations of the amount of power available for the needs of society.

Conventional fuels exist or can be made available from known resources in most parts of the world. Where the economy of an area has, with sufficient economic incentive, called for the use of energy, all that has been necessary has been to dig or to drill for fuel, to import fuel or to dam streams and to build power plants.

So far as concerns this country, the proven coal reserves are estimated to be adequate to the present power demands for the next 15 centuries. Here, at all events, energy starvation is not imminent. Whatever may be said as to the physical difficulties of transporting solid and liquid fuels into some areas, in the main any barrier that exists is primarily an economic one largely resulting from a thin general economy stemming from causes quite different from energy unavailability.

Atomic Fuel May Open New Areas

Undoubtedly there are areas, rich in certain raw materials, not too dependent on the transportation of large quantities of other materials for processing of the native materials but requiring large amounts of energy for process or for more extraction. If the transportation of the extracted raws or the processed materials out of such areas to the markets does not dovetail with the transport of conventional fuels in, if the human elements in populating such an area with suitable housing, subsistence and amenities are not a barrier and if market competition by more favorably located areas is not too pressing, then the ease of transportation of atomic fuels for "powering" the development may open new ranges of exploitation of the earth. How many such areas there may be is a matter of search and bold venture—atomic power supplies are not the sole criterion —they well may be the keys to open certain doors.

This is, of course, a matter quite different from noneconomic or "premium" application in which the economic criterion is of minor importance—such as outlying military and air bases and hospitalization centers, as to which the supply of conventional fuels may be prohibitive of any establishment.

A second exaggeration in the somewhat emotional broadcasting that has taken place has its origin in a too facile reasoning from analogue. It has been said that as Watts' improvement of the steam engine ushered in the industrial revolution so the atomic revolution is going, through power processes and almost solely through power development, to bring about a second great industrial revolution.

There are aspects of atomic development which would seem to carry possibilities of tremendous import to society. Most of these center about the possibility of creating substantial supplies of radio-active matter. There seems to be little doubt that through the channel of radioactivity therapeutic processes will markedly be improved and extended, that research in many fields, organic and inorganic, biologic, chemical and physical, will tremendously be advanced and that indeed through use as permanent catalysists and instrumentalities of measurement and control irradiated materials may profoundly affect our economy of production. So far as is generally known at the present the uses of such materials will be on a scale extremely small in comparison with the production from any probable power pile. Indeed in much of the expression by the informed scientific community such developments seem to be mentioned almost by way of parenthesis with the main emphasis on mechanical or electrical energy production.

Indeed a distinguished official said—"Atomic energy also creates a new source of power and heat that if properly developed can, in the course of the years, open the door of opportunity to millions now burdened sorely with drudgery and poverty."

The Record of Conventional Power Sources

Without for one minute attempting adversely to prejudge the contributions that atomic energy can make in this direction it might be well to bring into its proper perspective the contribution that the power arts have made to the

industrial development of the past century and a half.

Clearly without mechanical power the machine age could not have come into existence. It is sometimes forgotten, however, that the machine had at least an equal indispensability in our present type of industrial development.

The cotton gin, the power loom, the multiple-spindle spinning machine, the turret lathe and later the automatic screw machine, huge presses, processes of extrusion and the use of plastics, the adoption of tolerance limits and the assembly line have made possible the use of power and the production in quantity and at low cost of standard goods of far greater excellence on the average than hand products. Partial or full automatization of industry has been the outstanding element in bringing about the machine age—not to overlook the corporate form of enterprise and the processes of mass distribution and sales.

Watts' improvement of the steam engine, the development of water power, notably in the earlier years in this country in New England, the invention of electrical machinery and systems of transmission and distribution have, of course, contributed to our economic development as it stands today.

Conventional sources of power can, with no practical limits in sight, be further extended to meet the increasing needs of society, though obviously cheaper sources of power will facilitate extensions of the machine age to a greater or less degree depending on the significance of power costs in the production process.

Economic Aspects of Atomic Power

The problem here obviously becomes an economic one. If exceedingly low cost energy can be produced by any new process, certain forms of utilization will be more fully warranted economically. In those industries, however, in which the cost of power represents only a few per cent of the total cost of production it is evident that no new process of energy production, were it to be entirely without cost for the energy, significantly could affect economic expansion.

Perhaps this may be stated in a somewhat different way. We of the power industry have been proud of our contribution to mechanical civilization. Before the Great Collapse we were saying that the security of American prosperity lay in the fact that there were six horsepower back of the elbow of the average American workingman. That statement was correct but it didn't go quite far enough, or perhaps it went too far. Roughly speaking, these six horsepower might be represented by $900 of powerhouse and industrial distribution investment per workman. More lately industrial economists have shown that something of the order of magnitude of $6,000 worth of factory was necessary to create a job for one man. What this says is that after building the power plant and distribution system back of the worker's elbow, it was necessary to expend approximately seven times as much human effort to place at his hand the tools to utilize that power-house. The bigger job of relieving drudgery and poverty is bound to be in the creation of the capital instrument of utilization.

The reasoning by analogy may be quite sound if it contemplates new industrial processes that may flow from the use of radioactive materials. Similarly it probably will be quite sound if analogue illustrates what may be expected in therapeutic and research processes. The illustration is not as cogent when applied to power uses. We have had for scores of years highly developed systems of energy production and distribution. What is more important, an industrial economy has been built up taking full advantage of our energy production processes. These things being accomplished facts, it is not to be expected, whatever may happen in other fields, that power production from atomic sources will usher in a second industrial revolution. It well may be, however, that in certain segments of the economy newer processes of energy production may be a stimulus to growth and development.

No Change Forecast in T & D Systems

If we are right that our analysis in the main must be made in economic terms, we might go a little further and inquire as to where the economies of atomic energy production will be found. Nothing that has been said to date indicates that we may look for systems of transmission and distribution arising from atomic power plants, as such, different from what we have today. The bulk of the investment of human labor and of materials which makes the capital structure of our electric systems is to be found precisely here. Atomic energy then cannot be expected to bring about any saving in the dominant element in our electric power systems.

Moreover, all of the servicing costs which find themselves in the commercial processes, sales effort, accounting, administrative and executive expense and in the maintenance of our distribution systems clearly will remain substantially unchanged.

At the powerhouses themselves there is no hint that atomic energy will change the so-called electrical galleries or the switchyards. Indeed, there are even some possibilities of atomic energy development that may utilize the present turbo-generators. No serious suggestion in any event has been made that we shall be able to dispense with generators and turbines of sorts though we may, under some of the atomic possibilities, replace present ones with other presumably representing substantially the same capital costs.

If, on the other hand, steam cycles remain, the present capital investment in turbo-generators and their associated equipment or new investment in partial replacement of present units will be in the capital structure.

Atomic Pile May Replace Boilers

About all that is at present clearly in prospect is that an atomic pile with its handling equipment may replace our conventional boilers and fuel and ash facilities. This at least is a fair working hypothesis for our preview.

The economies that may take place back of the turbo-generator then are the principal hope of economic betterment by the development of atomic energy. These economies may be of great significance within the boiler room while at the same time it is too much to expect that they will radically modify the overall industrial structure of society. They may, of course, be significantly worth pursuing.

It is trite to suggest that the cost of heat production for use in a turbine—whatsoever the medium—is made up of capital costs and operating costs. Unfortunately a great deal of the popular discussion overlooks everything but the cost of the fuel itself.

For instance, it is well recognized that uranium 235 when segregated is a very expensive material and of relatively very rare occurrence as well as being utterly unsafe for society if left in the uncontrolled possession of possibly malevolent individuals or groups. It is not unthinkable that an "atomic boiler" might be produced to utilize the relatively cheap, highly abundant and entirely safe uranium 238. If so, all question of fuel cost

would be resolved in favor of atomic energy. With that would go the concomitant advantages of easy transportation and of enormous local storage within the walls of our power plants. The full possibilities here constitute one of the unknowns—unknown at least to those who are not "in the know."

Unfortunately that is not all that there is to the story. Assuming that our development of the new boiler will take the form of an atomic pile, we must know something about how the cost of that structure and its auxiliaries will compare with the equivalent items in conventional power plants.

Technical Problems Ahead

Present piles operate to produce heat at temperatures too low for practical utilization. There are enormous problems to be solved in producing a pile that will stand up under higher temperatures and using materials that will not be sufficiently neutron-absorbent prejudicially to affect the chain reaction essential to the process.

These piles and the parts removed from them in the normal process of maintenance and repair will be highly radioactive and such parts therefor, as well as the "ash"—fission products to the cognoscenti—will have to be removed mechanically within radiation shields of no negligible weight. It is obvious that a technique for this sort of thing can be worked out, but equally it is obvious that there will be a lot of trial and error and substantial capital investment. Nobody has suggested that the cost of the first such atomic boiler will be less than staggering — prohibitive indeed were there not prospects of economic advantage as our development progresses. We are, of course, not concerned so much with the capital investment as we are with the carrying charges on it. Judgment as to the latter will, short of experience, have to be based on probabilities. Will the piles and their parts be of long life or of short life, and what provisions will have to be made for the disposal of the radio-active structure of a pile when it has come to the retirement age?

It has been said repeatedly that the mass of the screening is so great that energy piles will probably not be effective except for very large stationary plants and for large mobile plants, such as those in naval craft, which warrant departure from narrow economic considerations. The problems of maintenance and renewal of parts, quite as much as the initial mass involved, would, in stationary plants of less than major size, seem very effectively to rule out the possibility of the use of atomic energy. What economic advantages may ultimately be found to accrue from the use of atomic energy for power purposes evidently then will come into systems distributing energy rather than into the lesser isolated plants, and, granted development within the compass of the free enterprise system, should serve to strengthen rather than to weaken the position of utility undertakings.

If, as seems probable, the strictly economic advantages of atomic sources of energy occur in a reduction of operating costs, with perhaps relatively heavy fixed charges due either to high capital cost, to high depreciation rates or to a combination of them, and if, as again seems probable at least initially, the net advantages are not sufficient to warrant supersession of existing investment, it may be expected that the introduction of atomic energy plants, when it comes, will be in the form of base load units installed progressively to meet load growth. This again would indicate adaptability of growing energy-supply systems rather than to smaller or fixed requirements for power.

The introduction of atomic energy equipment as base capacity to meet load growth clearly would indicate a continuing economic usefulness for by far the major portion of present conventional plant investment. This, with the unimpaired usefulness of switching, transmission and distribution investment goes a long way to discounting the probability set forth in an official report so far as concerns the utility industry. This report says—"Great industrial installations representing nationwide investments, employing many thousands of workers, might be rendered obsolete." With the operation of normal economic forces there seems little reason to anticipate any less favorable effect than that which in recent years has accompanied the introduction of high temperature, high pressure steam cycles and improved combustion processes.

Utility Industry Will Welcome Atomic Power

As this industry in the past has not only met but welcomed and actively stimulated improvements in the power arts, so it may fully be expected, to the extent allowed, vigorously to bring forward any possibilities offered by nuclear processes.

Indeed, it seriously may be questioned whether the fullest power possibilities of this new technique can as speedily or as fully be developed without the collaboration of this industry. Without wishing for one moment to arrogate to ourselves all knowledge, it may fairly be claimed that the extensive experience, both in volume and in time—economic, commercial, and technical—represented within the industry can make a valuable contribution to the application of atomic energy to the service of the nation and that nowhere else can such group of experienced people backed by a fund of factual knowledge be found.

Two difficulties at present and for perfectly understandable reasons retard the initial collaborative effort of the industry.

The destructive possibilities of fissionable materials are so frightful that the release of information on which to base developmental speculation has been closely restricted. There can be no criticism of such restriction if it is essential to national security or to the preservation of international order. There may be question, however, whether part of the restriction doesn't go beyond the necessities in the case, and indeed whether it is not almost inevitably futile. Nonethe-less the course of wisdom lies in some measure of restriction until such time as a program can be developed that will insure full reciprocity in the entire release of such knowledge and experience as may be acquired.

Restrictions on Data Hamper Scientists

The general scientific facts are, of coure, well known. Quantitative scientific data are not so widely available, and, more particularly, important technologic and practical information is still very closely restricted. It is precisely this latter sort of thing that is most necessary not only to power development but to intelligent appraisal of the possibilities by those most competent to appraise, namely, men intimately conversant with the operational and economic characteristics and possibilities of power systems both in their present conventional aspects and in the range of a newer technique.

It is important that at the earliest possible date a program be established for the freer dissemination of all knowledge that is available in this new field. This is not a matter of interest to the public utilities alone or even primarily to the public utilities. Despite certain

practical necessities at some times and in some areas, secrecy is fundamentally abhorrent in our social and economic relations. It is particularly dangerous when the secrets are entrusted to a relatively small group within a government. Indeed the question fairly may be raised whether there is greater risk in a somewhat too free dissemination of knowledge which may benefit a possibly hostile foreign power than there is in withholding too much information internally from all the people and entrusting it to a selected few within the government.

Whatever may be said as to the propriety of reticence on the part of individuals as to their private knowledge, there is a serious question as to the desirability of a government, by its own act, restricting to a small group of individuals knowledge which might benefit all the people and which for its fullest application requires the collaboration of all who can effectively contribute their experience and their resources. It is therefore a matter for gratification that there is promise of "declassification" of some restricted data in the near future.

The second impediment to industry collaboration in the development of power from nuclear sources lies in the tacit assumption that necessarily permission to use or, within a rather vague definition, to produce fissionable materials must be highly restricted.

Atomic Experiments not Necessarily Hazardous

Here we must not be blind to the realities. It is frankly recognized that the possession by individuals of relatively small quantities of segregated explosible materials would constitute a menace to domestic order and to international security. It does not necessarily follow from this, however, that all power development from atomic sources must be by a central authority. It is conceivable that energy safely may be derived from nonfissionable materials, that in such a process unsegregated fissionable materials may be produced and that the very nature of such a process may be such as almost automatically to prevent the accumulation in segregated or in rich form of sufficient fissionable material to be at all hazardous. It is conceivable that the degree of automatic safeguard of such a process can be supplemented by simple and effective controls sufficient to permit the wide entrustment to business organizations of the beneficient processes of atomic energy.

Here again the absence of factual knowledge prevents much more than speculation by those who are not "in the know."

It is suggested that resourcefulness addressed to the minimizing of centralization and control rather than to a highly elaborated centralized control might secure the blessings of safety while at the same time retaining the advantages of widely disseminated initiative.

So far as concerns the public utility industry and its use of atomic energy under minimal controls a few considerations clearly would serve to bring forward the earliest effective development.

A representative of an industry association, testifying before the Special Senate Committee on Feb. 18 of this year, stated the conviction that whatever net economic advantage results from the use of atomic energy in central power development should be required to be passed on to the consumers. This means that after due consideration of developmental cost the consuming public should be given full advantage of any by-product stemming from an enormous war-time development conducted at public expense. It does not mean that the introduction of atomic energy into our distribution systems should be used in a discriminatory way as an instrument for forcing ideological philosophies. License to operate should be conditioned only on the requirement of transmission of the benefits to the ultimate consumers, the observation of all requirements for the protection of individuals against the inherent dangers in the process and the safeguarding of national security.

Local Level Regulation Suggested

Necessary personal and national safeguards properly should be established and rigorously maintained by such central governing commission as is set up; the transfer to the customer-public of the economic benefits most wisely will be insured under our present accustomed method of regulation on the local level.

The sound introduction of atomic sources into the electric power field will be promoted as the extent of generally available knowledge is increased. Any real advantages will zealously be prosecuted by the utility enterprises of the country, public and private alike. Unrealistic exaggeration of the benefits will be harmful rather than helpful, and anything remotely resembling forced adoption will fall short of its purposes.

One major economic uncertainty in the way of spontaneous introduction of atomic sources will need to be resolved after the technologic problems have found expression in terms of probable dollars and cents.

It seems quite clear that whatever is done will be in the way of multi-purpose development. The production of radioactive material is one of the functions. Our present knowledge and crystal-gazing do not seem to indicate that this will make any extraordinary contribution to carrying the overall costs however great the social or industrial values of artificially irradiated materials may be. This is primarily a question of relative physical quantities.

In a somewhat different category, however, falls a third function or perhaps it may be a main function. If the pattern of national defense or of international security requires the production, segregation and accumulation of large quantities of explosible fissionable material, power development may, as suggested in the Bill now before the Senate, become definitely a by-product of a main non-revenue production function. Squarely here we find ourselves faced with a problem of cost allocations, the answer to which will be found with difficulty and certainly only after we have a fuller perspective of whether the world can live in peace or whether it is hell-bent on blowing itself to pieces. This still remains the Number One question in connection with atomic energy. To the people of this country and of the world, however, attractive cheap power as a more or less subsidized by-product, the necessity for a principal destructive product for killing off one another is too great a price to pay.

International Security the Major Problem

In our thinking as to atomic power sources then I feel warranted in saying that power development must stand on its own feet or alternatively that we shall have to look to the future with misgivings as to the fitness of the human race for survival. Despite the difficulties of this transcendent question I am not a pessimist. I mean simply to say that it is vastly more important than any minor question of the cost and plentifulness of power production and the more likely of rational solution as it is kept free from unnecessary secondary purposes. If we fail in the major problem of international security all that we can do in developing power more plentifully will be as the tinkling of hollow brass.

Basic Ideas Underlying the Utilization of Atomic Energy for Power Production

By Dr. Kenneth H. Kingdon

In Charge of Nuclear Research, General Electric Research Laboratory

Address before the Annual Meeting of the Edison Electric Institute, New York, N. Y., June 3, 1946

I. Introduction

WE are all acquainted with the idea of getting heat, or energy, from an ordinary chemical reaction. Ordinary combustion is probably the most familiar chemical reaction, and in combustion we know that carbon and oxygen combine to form carbon dioxide molecules. The carbon atoms needed for the reaction might be supplied as a lump of charcoal, and the oxygen atoms exist in pairs as oxygen molecules in the surrounding air. To start the combustion we heat the charcoal and air enough to make some carbon and oxygen combine to form molecules of CO_2. This reaction can take place because in the CO_2 molecule the three atoms are more tightly bound together than were the carbon atoms in the lump of charcoal, or the oxygen atoms in the oxygen molecules of the air, and this increase in binding of the atoms is the source of the heat liberated in the combustion reaction. The heat liberated by the formation of CO_2 is more than sufficient to heat adjacent carbon and oxygen to the combining temperature, so that once the reaction is started in the charcoal lump, it continues until the whole lump is consumed. In other words it may be described as a self-propagating reaction or a chain reaction.

The combustion reaction just described is one in which simple substances combine to form a product whose molecules are more complex, that is, it is a synthesis. There are also many chemical reactions in which complicated molecules are broken down into simpler ones. Most explosives employ reactions of this decomposition type. For example, when ammonium nitrate (NH_4NO_3) explodes, it decomposes into the simpler molecules of water, nitrogen, and oxygen. The atoms of hydrogen, oxygen and nitrogen are, on the average, more tightly bound in the product molecules than they were in the original ammonium nitrate, and this tighter binding is the source of the explosive energy.

I have gone at some length into producing energy from chemical reactions by synthesis, or by decomposition, because energy may be obtained from nuclear changes in exactly similar ways. The elementary units with which we deal in nuclear reactions are the protons and neutrons of which nuclei are built up, and by changing the grouping and binding of these protons and neutrons, by forming them into different nuclei, we may obtain energy from the nucleus.

The first figure illustrates the kinds of changes by which we may get energy from nuclei. Along the horizontal axis is plotted the total number of particles in the nucleus, that is, the sum of the numbers of protons and neutrons. The position of a nucleus, along the vertical axis indicates the energy which may be obtained from it by regrouping its component protons and neutrons into different nuclei. That is, the nuclei in which the protons and neutrons are most tightly bound together lie near the bottom of the curve. This group includes elements such as sulphur, calcium, iron, iodine and barium, having atomic weights between 30 and 140. The very light elements lie at the extreme left of the curve, and if two or more of these light nuclei could be combined to form a heavier nucleus, the curve indicates that heat (or energy) should be liber-

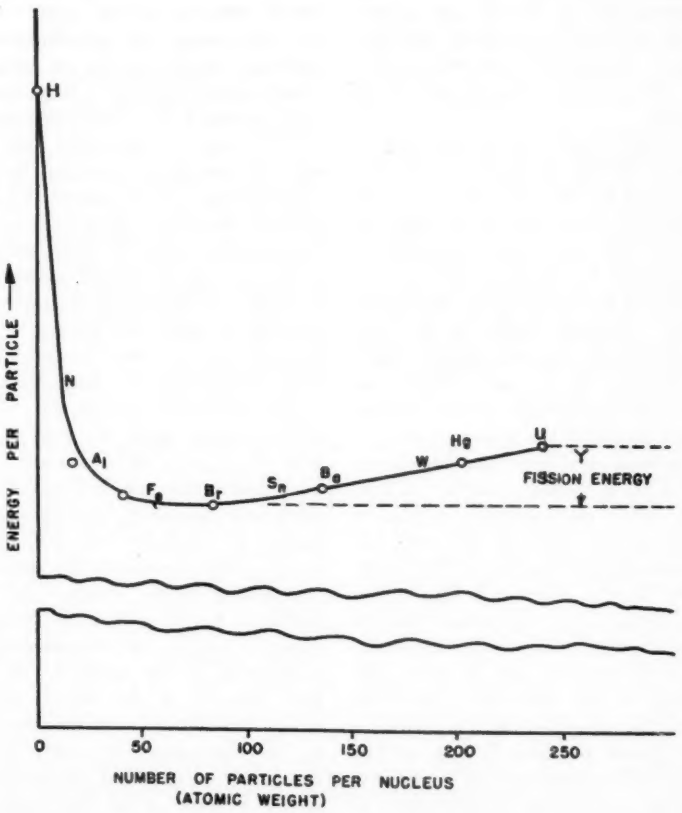


Fig. 1

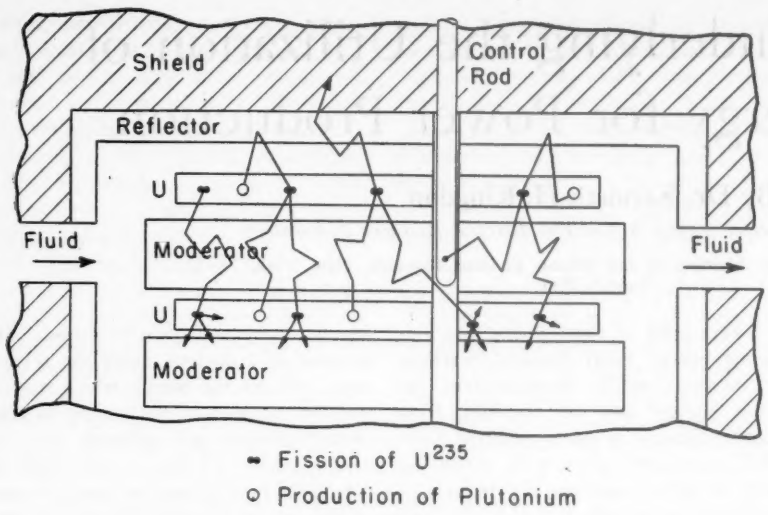


Fig. 2

ated. Such a process would be exactly analogous to a chemical reaction like combining carbon and oxygen to form CO_2. Hydrogen lies at the very top left of the curve, and if hydrogen nuclei (that is, protons) could be combined to form helium, large amounts of heat should be liberated. Just this process is thought to go on in a somewhat roundabout way in the sun, and is probably the source of heat which maintains the sun's temperature. So far no process of this sort has been carried out on the earth.

The heavy nuclei lie at the right of the curve, and we see that if one of these nuclei could be split into two parts corresponding to two new nuclei near the bottom of the curve, large amounts of energy should be liberated. This process is analogous to the explosive decomposition of a complex molecule like ammonium nitrate into the simpler molecules of water, oxygen, and nitrogen, but involves rearrangements of the nuclear particles instead of the whole atoms.

It has been established that the energy liberated in a nuclear reaction is connected with a disappearance of mass in the reaction, and that, in fact, this loss of mass is an exact measure of the energy liberated in the reaction. This is the famous principle of the equivalence of mass and energy derived on theoretical grounds by Einstein just 40 years ago. According to the quantitative formulation of this principle, the disappearance of one pound of mass in any nuclear reaction will be accompanied by the generation of 11.4 billion kilowatthours of energy. We may appreciate the enormous scale of this conversion factor by recalling that the electrical power consumption in the entire United States was about 220 billion kwhr in 1944.

II. Uranium Fission

This enormous store of nuclear or atomic energy would have remained entirely inaccessible to us in any practical way, were it not for the peculiar and special behavior of one quite rare kind of atom among the approximately 275 different atomic species or isotopes of which ordinary matter is composed. This rare material is called uranium 235 (U^{235}) and it constitutes only 1/140 part of uranium as it occurs in nature. The nucleus of U^{235} contains 92 protons and 143 neutrons ($92 + 143 = 235$). The peculiar property which makes it so unique among all atomic species is that it readily absorbs an extra slow neutron, forming a compound nucleus which is unstable and at once breaks into two major fragments of comparable mass.

The compound nucleus does not split into two equal parts, nor does it always split into exactly the same parts. It has been found that the split occurs somewhat more readily if the fragments have masses of approximately 140 and 90 units. The fragments fly apart with tremendous kinetic energy, the lighter fragment having somewhat the greater energy in order to satisfy conservation of momentum at the breakup. It is this high velocity of the fission fragments which furnishes most of the heat energy for an atomic explosion or for an atomic source of power. The energy liberated in the process, if all the atoms in a pound of U^{235} could be made to undergo fission, would be 11 million kilowatthours. This liberation of energy occurs because the fission fragments as a result of their different nuclear binding weigh about 1/1000 lb. less than the original pound of U^{235}, and this loss of mass appears as a gain of kinetic energy according to the law of the equivalence of mass and energy. The energy equivalent to the 999/1000 lb. mass of the fission fragments is at present entirely inaccessible to us.

The two most important things about the fission of uranium are, first, the high kinetic energy of the fission fragments which thus serve as a source of heat, and second, the liberation of neutrons which accompanies the breaking up of the U^{235} nucleus. From 1 to 3 neutrons are liberated by the fission of a single nucleus, so that as the fission itself is produced by neutrons, it is clear that the ingredients for a chain reaction are now at hand. A chain reaction once started should pursue an extremely violent course until all available ingredients are consumed. Neutrons and fairly pure uranium ore both occur in nature, so we may ask why a chain reaction of this sort did not start long ago and continue until all usable uranium had been consumed. The reason is, obviously, that very special conditions are necessary in order to make the chain reaction go, and we shall now inquire into these conditions.

III. Structure and Operation of Pile

The kind of structure which has been developed to release nuclear energy, by means of the phenomenon of uranium fission is called a pile, and is shown schematically in Fig. 2. It has two main components, the active fissioning material (uranium), and the moderator. These are surrounded by a neutron reflector and a protective shield. Control rods are provided to regulate the chain reaction, and a heat exchange fluid to remove heat. The moderator is made of some element like carbon or beryllium which does not capture neutrons readily, but whose atoms are quite light so that when a fast neutron collides with one of these atoms some of the momentum of the neutron is transferred to the atom and the neutron is slowed down. As indicated in the figure, the uranium is arranged in a space-lattice of rods set in holes in the moderator structure. When an atom of U^{235} undergoes fission in one of the rods it emits fast neutrons, which have a good probability of escaping from this rod without much loss of speed, and

without producing nuclear reactions in the rod. These neutrons then enter the moderator, and are slowed down by collisions with the atoms of the moderator until they are of sufficiently low speed to be captured by uranium nuclei. The slowed neutrons may then enter another uranium rod and produce the desired nuclear reactions there.

The most essential of these reactions is, of course, the fission of U^{235} atoms so that a chain reaction may be sustained in the pile. That is, the fission of a U^{235} atom produces several neutrons, and things are arranged so that one of these causes fission of a second U^{235} atom. A neutron from this second atom causes fission of a third U^{235} atom, and so on in an endless chain. It is this possibility of producing a chain reaction by the emitted neutrons which chiefly distinguishes uranium fission from all the other energy-liberating nuclear reactions which were discovered previously, and which makes this reaction suitable for the practical production of atomic energy.

These neutrons are essential for the operation of the pile. They are being produced continually by the fission of U^{235} atoms while the pile is in operation, and after a short life disappear by being captured by other nuclei. Fig. 2 attempts to show in some detail what might happen to a single generation of 10 neutrons produced in the upper uranium rod. Since from 1 to 3 neutrons are produced per fission, these 10 neutrons must have come from the fission of at least 4 atoms of U^{235}: These 4 atoms are shown as 4 double dots in the upper rod. In order to maintain the chain reaction, 4 of our neutrons must be used to cause fission of 4 new U^{235} atoms. This has been indicated as occurring in the lower uranium rod, thus giving rise to 10 new neutrons to maintain the chain.

IV. Production of Plutonium

The production of these neutrons requires the destruction or consumption of U^{235}, which is quite a scarce material as it only constitutes 1/140 part of natural uranium. Fortunately, there exists a second nuclear reaction which makes it possible to utilize most or all of the U^{238}, which is the major constituent of natural uranium. This process involves the formation of the new element plutonium in the pile. In this process the slowed neutrons in the pile are also taken up by atoms of U^{238} to form another new element, neptunium, which in a short time changes spontaneously into plutonium. Plutonium is like U^{235} in that it undergoes fission when it captures a slow neutron, and so is also suitable for the operation of a chain-reacting pile. Accordingly, if we wish to use our uranium supply efficiently, things should be arranged, if possible so that four of the group of ten neutrons will interact with U^{238} to produce four atoms of plutonium. These 4 atoms of Pu may be considered as replacing the 4 atoms of U^{235} which were consumed in making the 10 neutrons, so that our store of fissionable material in the pile is maintained. It is clear that if the pile can be designed so as to maintain the supply of fissionable material in this way, it will be possible to keep it in service for longer periods before extensive servicing is needed.

It should be emphasized that at present U^{235} is the only naturally occurring fissionable material of practical importance, and, therefore, the supply of U^{235} should be conserved rigorously. Starting with U^{235} it is possible to make fissionable materials from U^{238}; but without U^{235} this is at present impossible on a practical scale.

V. Control of Pile

We have now traced the life history of 8 of the 10 neutrons with which we started initially. One of the remaining two is shown as being absorbed by the control rod. The control rod contains some material like boron which readily captures slow neutrons. It is clear that if this rod had been pushed a little farther into the pile it would have captured two of the neutrons, and so prevented the fission of a new U^{235} atom. This would have stopped the propagation of the chain reaction and caused it to die out. Similarly, if the rod had been withdrawn farther from the center of the pile it would not have captured any of the neutrons, and 5 atoms of U^{235}, instead of only 4, would have undergone fission in the second generation. The chain reaction would, therefore, have expanded, and the neutron population of the pile would have increased in an exponential, or compound interest, way as time went on. The control rod must, therefore, be positioned so that the multiplication factor for the neutron population is exactly unity in order that the pile may remain at a constant level of operation. The heat generated per second in the pile is determined by the number of fissions occurring per second, and this is related to the neutron population of the pile as explained above, so that to hold a constant power level the neutron population must remain constant. If the pile is operating at a stable power level of 10,000 kw, and it is desired to raise the level to 20,000 kw, the control rod is moved farther out so that the neutron population of the pile increases at a suitable rate. When the power level has reached 20,000 kw, the control rod is pushed in again to hold the power constant at this new level. The control rod thus differs from the fuel control on a boiler in that the control rod may be at the same, or approximately the same, position for two widely different power outputs. It is clear, however, that this does not imply any instability in the operation of the pile, and, in fact, it is reported that the piles are extremely stable in operation.

VI. Size of Pile

The tenth neutron of our initial group is shown as escaping from the active part of the pile and being absorbed in the shield. If too many neutrons escape, the chain reaction cannot take place, and it is clear that this requirement fixes a minimum size for the pile. In other words the pile must be big enough for a large enough fraction of the neutrons to be captured by atoms of U^{235} before having a chance to escape from the pile. It is clear that if the percentage of U^{235} in the pile is artificially increased the dimensions of the pile may be made smaller because the neutrons will encounter atoms of U^{235} after traveling proportionally smaller distances. The smaller size which can be attained by this enrichment will be needed in applications where the weight and size of the pile are important requirements.

VII. General Remarks on Neutron Economy

It should be emphasized that the distribution of neutrons outlined in the preceding paragraphs is intended to be illustrative rather than quantitative. Actually it may be impossible to utilize so large a fraction of the neutrons in plutonium production, even though it is obviously desirable to do so. Similarly, it would be desirable to expend a smaller fraction of the neutrons in the control rod. It should also be emphasized that the neutrons are actually present in the pile in enormous numbers. This will be evident when it is recalled that the production of kwhr of energy requires

the fission of about 1.1 x 10^{17} atoms of U^{235}, so that a comparable number of neutrons must have been generated and consumed in the pile while producing this energy.

VIII. Fission Fragments, Heat Transfer, and Radioactivity

The two main fragments into which the U^{235} atom splits when it undergoes fission fly apart with very high velocity. This kinetic energy is rapidly communicated by collisions to neighboring atoms, and therefore, appears as heat in the surrounding material. The range of the fission fragments is less than 0.001 inch in most solids, so that practically all this heat is generated in the active rod in which the fissions occur. The fission fragments are so energetic that they could heat the rod to any temperature which it could stand without damage. It is desirable to transfer the heat at as high a temperature as possible in order to obtain efficient utilization in a heat engine. Therefore, the active rods should be operated at as high a temperature as is consistent with their mechanical and chemical stability. Operation at sufficiently high temperature is one of the chief problems which must be solved in developing a power pile. Nuclear properties are of prime importance in selecting materials for use in a power pile, but mechanical and chemical stability at high temperatures are also of great importance.

In addition to having high kinetic energy the fission fragments are also unstable in a nuclear sense, that is, they are extremely radioactive, and approach stability by successive transformations to different elements, finally reaching one which is stable. Some 30 different stable elements have been identified in the fission products, plus a considerably larger number of unstable radioactive isotopes. These transformations, of course, represent an additional liberation of energy, but it is small in amount compared with the kinetic energy of the fission fragments. Some of this radioactive energy appears as beta rays or high speed electrons, and this energy is also mainly converted to heat in the active rods. The rest of the radioactive energy appears as gamma rays or x-rays, and this is converted to heat throughout the whole body of the pile and shield. In all cases it appears that the energy must be recovered as heat for useful purposes, and that practically none of it can be, for example, converted directly into electricity.

To those of us who are accustomed to thinking of conventional radiation phenomena as presented by x-ray tubes, radium, and ordinary nuclear experimentation, the pile presents radioactive radiations on an almost inconceivably large scale. The neutron and gamma, or x-ray, radiations from the pile are so intense, that human exposure to their direct effects for even a small fraction of a second would be fatal. Accordingly the pile must be surrounded by an absorbing shield several feet thick to protect personnel from the neutron and gamma radiations. The thickness of the shield is necessary on account of the very penetrating character of these radiations. The neutrons are slowed down by collisions, and finally captured by the nuclei of atoms in the shield. The gamma rays from the fission products, and from the captured neutrons, first give their energy to electrons in the shield, and the energy of these electrons is finally dissipated as heat vibrations of the atoms in the shield. The principles underlying these absorption phenomena are well understood. It should be pointed out that the amount of radiation escaping through the shield decreases exponentially as the thickness of the shield is increased. Hence a doubling of the power of the pile, and, therefore, a doubling of the amount of radiation incident on the inside of the pile, would not by any means require a doubling of the thickness of the shield.

IX. Safety

It is necessary that any discussion of a uranium power pile should place a great deal of emphasis on the safety requirements which must be fulfilled by the shielding, but it should not be inferred from this that the operation of such a pile is an extremely hazardous undertaking. The hazards peculiar to the pile may be divided into three groups (1) The possibility of the chain reaction getting out of control and producing something like a violent boiler explosion, (2) Hazards from the radioactivity of the pile in normal operation. (3) Hazards incurred from radioactivity in transferring material to or from the pile. As regards (1), extra safety control rods can be provided which can be automatically inserted in the pile whenever the energy output of the pile increases too fast, and which will absorb so many neutrons that the chain reaction cannot take place. As regards (2) and (3), measuring instruments are available which can detect much smaller amounts of the dangerous radiations than are toxic to humans, so that hazards from this cause can be detected and controlled long before they become dangerous.

X. Poisoning Effects in the Pile

In the preceding discussion of the neutron economy of the pile, the only neutrons which did not take part in the fission and plutonium processes were those which escaped from the pile, and those which were absorbed in the control rod. In reality neutrons are also absorbed by the moderator, by the heat-transfer fluid, and by structural materials and pipes used in the pile. In addition to this, certain materials, which may be present in very small quantities as impurities, may be very active absorbers of neutrons, and so may act as poisons which, if present in large enough amounts, would stop the chain reaction. A material of this sort is boron, which is often present as an impurity in graphite. This means that particular attention must be paid to the purity of the materials used in the pile. There is, however, one class of poison impurities which is inherent to the pile. We have seen that the fission fragments yield several dozen different elements, some of which absorb neutrons very readily. These fission products are accumulating whenever the pile is producing power, and eventually would poison the pile enough to stop the chain reaction. It will be necessary, therefore, to remove the active material periodically from the pile and extract the poisons. It is thought that the pile can be designed so that this need only be done at long intervals thus making economical and practical operation of the pile possible.

XI. Radiation Stability

All materials in the pile are continually being traversed by large numbers of neutrons and by intense gamma radiation. These radiations produce changes in the atomic structure of all materials in the pile. Neutron collisons displace atoms from their normal places in the crystal lattice. New elements are formed by nuclear transmutations caused by the radiations. As a result of this the physical properties of all materials in the pile may be profoundly affected after long-continued operation. The

(*Continued on page* 224)

Nuclear Research in General Electric

By Dr. C. G. Suits
Vice President, General Electric Company

Address before the Annual Meeting of the Edison Electric Institute, New York, N. Y., June 3, 1946

THE generation and conversion of energy in its various forms has been an important part of the activity of the General Electric Company from the time of its founding. The research knowledge and the engineering and manufacturing know-how of the methods of energy generation and conversion, especially relating to electrical energy, are well developed within the organization of the Company. The scope of this activity includes electrical generators driven by steam turbines and water wheels as well as mercury boiler and turbine systems, and the more recently developed devices such as gas turbines, superchargers and jet propulsion motors. The chemistry, metallurgy and physics of these prime movers and their associated systems and auxiliaries have been an object of study in many of the twenty laboratories of the Company for a long time. Short term investigations and long term fundamental researches have yielded much basic knowledge of the properties of materials of construction, such as the creep and rupture of metals and alloys at elevated temperatures and the chemical and physical stability and corrosion properties of alloys under mechanical and thermal stress. Similarly, the problems of the flow of fluids, the mechanical problems associated with testing of materials, and the instrumentation of such methods, have led to a pattern of research, development, and engineering well suited to the broad problems of power production and its future development.

The release of nuclear energy on a large scale has brought about a complete re-examination of the problems of power production in the light of the new possibilities thus presented. This study has not shown in any final form what the atomic power plant of the future will be, but it has made it possible to sketch in some of the outlines of the picture. Most important, however, it has led to a realization of the scope of the problems of atomic power plant development, placed a tentative time scale on the project, and has consequently indicated the scale of the research and engineering effort required for the job.

It has seemed inevitable to us that the electrical manufacturing companies, with their long experience and impressive technology in power production, would take a leading part in the atomic power problem, and in the national interest could indeed do no less. Planning has therefore gone forward with that objective in mind. This problem, more than any other single factor, has had an important influence on the planning of research in the General Electric Company.

A careful assessment of this task has shown that the development of economical atomic power will not come about as a simple by-product of the atomic bomb. A tremendous amount of knowledge gained from the bomb project will have application to the problem of atomic power production, but a great deal of research must be done to arrive at an answer which will be of practical interest to the electrical power industry and other users of prime movers.

The scope of this problem was influential in the decision arrived at some time ago to move the Research Laboratory from the crowded Schenectady manufacturing plant area to the Knolls, a 300 acre site outside of Schenectady on the banks of the Mohawk River, where a completely new research establishment with all its facilities will be erected. On this site there is room for the special buildings and equipment of nuclear research — cyclotrons, betatrons, fission piles, linear accelerators, and devices yet to be invented. Some of these tools of the science require space for protection from radiation hazard, some require the natural shielding that is best obtained by a favorable topography, some require abnormal amounts of process water—the Knolls site is ideal for these purposes.

Eventually a very large group of research scientists will have to be engaged in this work. Fortunately, a considerable number of individuals with valuable experience gained on wartime nuclear research have joined our laboratory, many of them in anticipation of the possibility of applying their efforts to the peacetime task of the nucleus—power production.

The Nuclear Research Projects

A long range program of nuclear research has been laid out with two main lines of attack, (A) an exploration of new types of nuclear reactions, especially with recently developed electron accelerators, and (B) an investigation of nuclear fission for its power production possibilities. Since (A) is at present the more active program, it will be described in some detail. The projects under (B) will be outlined but in many cases they are not yet implemented by necessary experimental equipment and facilities.

Work under (A) at present includes the development of electron accelerators and their use in nuclear experiments. Progress in science in the nuclear field, as well as in most others, depends upon the development of the scientific tools. Accelerating devices have been and are powerful tools in nuclear work and it is appropriate that their development should occupy an important place in the nuclear research program.

The Betatron and Its Kin

The study of high voltage devices for the production of X-rays has been a long standing activity of the Research Laboratory,[1] culminated by the development of the resonance transformer equipment for 1mev and 2mev X-radiation.[2] This type of electron accelerator and X-ray generator can doubtless be built for considerably higher radiation energy. Five mev is clearly possible, but there appear to be few radiographic or therapeutic applications of such energy. For nuclear experimental work the resonance transformer has not been as suitable as competitive devices of similar energy but lower output.

Our interest in the betatron was originally due to its possibilities as an X-ray

[1] W. D. Coolidge, GE Rev., V. 28 No. 3, 182 (1925).

[2] E. E. Charlton and W. F. Westendorp, GE. Rev., V. 44 No. 12, 652 (1941).

E. E. Charlton and W. F. Westendorp, Pros. 1st Nat. Elect. Conf., Oct., 1944.

generator. Its suitability for radiography needs more investigation but it appears to have possibilities in ratings up to 20 mev. The most interesting therapeutic use of the betatron may be in the 50 mev range.

Dr. Kerst[3] of the University of Illinois built a small betatron prior to World War II which developed over 2 mev although it was only 20 inches in largest dimension. This machine produced sufficient X-radiation intensity to be of possible interest for radiography. As a result, Dr. Kerst[4] came to the GE Research Laboratory and built a 20 mev betatron which operated successfully and was subsequently loaned to the University of Illinois upon Dr. Kerst's return to that institution. The 20 mev machine had shown the feasibility of extrapolating this design to higher energies so that Dr. Charlton and Mr. Westendorp[4a] of our Research Laboratory designed and built a 100 mev betatron which has been in operation for nearly three years. This device is the most energetic accelerator in existence anywhere and is currently being used to explore its radiographic and therapeutic possibilities as well as its possibilities for investigating nuclear reactions.

The principle of the betatron is quite simple. The advice may be regarded as an alternating current transformer, the secondary coil of which consists of a doughnut-shaped vacuum tube. Electrons are injected into this doughnut from an electron gun and they travel a circular orbit for a great many revolutions, acquiring during each turn the same voltage increase as though they had flowed through wire occupying the same space. The conditions for determining whether the electrons will find a single stable orbit rather than assume a spiral or more complicated path, were worked out many years ago by Wideroe.[5] Very briefly, this condition for stability is satisfied by properly grading the magnetic field by shaping the poles of the magnet in which the "doughnutron" is placed.

Further amplification of the underlying principles of electron acceleration by magnetic induction were made by other scientists, including Walton[5a], Jassinsky[5b], and Steenbeck[5c]. Steenbeck[5d] described some early experimental results with an induction accelerator he built in accordance with these principles.

Betatrons may be designed for a wide range of energies. As the energy increases, however, the weight of the laminated iron core increases as the cube of the energy. The core of the 100 mev betatron weighs about 130 tons. If substantially larger betatrons are constructed of the same design, the core required will become extremely large and costly. This has led to a careful consideration of alternative methods of electron acceleration and some designs have been developed which bear promise of going to very much higher energies than would be possible with the betatron, although not without considerable increase in complexity of the associated equipment.

The simplest improvement in the betatron design employs a DC bias principle.[6] The betatron just described accelerates electrons for approximately ¼ cycle of the alternating current supply, that is, electrons are injected near the zero point of the magnetic field and accelerate during the increase in field to its maximum. However, the accelerating force which is the electric field due to the varying magnetic flux is in the right direction for ½ cycle. In the biased betatron electrons are injected at the negative maximum of the magnetic field (which is biased to zero with direct current) and accelerate through ½ cycle of the alternating current to the positive maximum of the magnetic field.

By the use of this principle and some other improvements that may be used with it, it is possible to get substantially higher energies with the same weight of magnet. We are modifying the pole faces of our 100 mev machine for biased operation and expect to obtain 170 mev with relatively small changes in the core. Since no serious difficulties of this method have yet been discovered, the biased betatron may very well replace the earlier type, especially at the higher energies. Biased betatrons have been built for 10 mev and 1920 cycle operation experimentally in the Laboratory. A 50 mev biased betatron is now under construction for the further exploration of this principle.

Veksler[7] and McMillan[8] published analyses of accelerating devices which pointed to the attractive possibilities of combining the use of a magnetic field and an electric field in a single device. This device, which has acquired the name "synchrotron," employs a magnet and a doughnut-shaped vacuum tube similar to the betatron. The vacuum tube, however, incorporates a high frequency resonant cavity energized by a radio frequency oscillator. Electrons are injected into this doughnutron cavity at relatively high energies, take a circular path because of the magnetic field and acquire a stable orbit because of the shaping of the magnetic field according to Wideroe's principle. The chief accelerating force, however, is provided by the resonant cavity through the gaps of which electrons acquire multiple acceleration in the electric field, very much as in the cyclotron. By the use of this principle, one may hope to accelerate particles to still higher energies than the biased betatron having a given weight of magnetic material.

Because the acceleration is chiefly provided by the electric field, there is a considerable change in the diameter of the orbit during the complete acceleration cycle. This leads to a practical difficulty in the design of the doughnutron, which must have a cross-section that is awkward to construct. To overcome this difficulty, Dr. Pollock[8a] of our Laboratory evolved a design of an accelerating device which consists of a miniature betatron built within the structure of the synchrotron. In effect, the betatron supplies 2 mev electrons for injection into the synchrotron cavity. Electrons of 2 mev energy have a velocity which is already 98 per cent of the velocity of light, so no great change in orbit diameter with subsequent acceleration is required. This appears to be a practical solution of this problem and is being employed on most of the synchrotrons now being constructed.

We are building a device of this kind, sometimes called a "sigmatron," which will employ a magnet weighing 8 tons, and will, it is hoped, attain an energy of 70 mev. McMillan and his associates at the University of California at Berkeley are building a larger one with the objective of obtaining 300 mev energies.

---

[3] D. W. Kerst, Phys. Rev. V. 60, 47 (1941).
[4] D. W. Kerst, Phys. Rev. V. 61, 93 (1942).
[4a] W. F. Westendorp and E. E. Charlton, J. Appl. Phys. V. 16, 581 (1945).
[5] Wideroe, Arch. f. Elektrotech V. 21, 400 (1928).
[5a] E. T. S. Walton, "The Production of High-speed Electrons by Indirect Means," Proc. Camb. Phil. Soc. 25, Pt. IV, 469-481 (October, 1929).
[5b] W. W. Jassinsky, "Beschleunigung der Elektronen im elektromagnetische Wechselstromfeld," Archiv. f. Elektrotechnik 30, 590-603 (1936).
[5c] M. Steenbeck, U. S. Patent 2,103,303 (December 28, 1937).
[5d] M. Steenbeck, "Beschleunigung von Elektronen durch elektrische Wirbelfelder," Naturwiss. 31, 234-235 (May 7, 1943).
[6] W. F. Westendorp, J. App. Phys. V. 16, No. 11, 657 (1945)
[7] Veksler, J. Phys. USSR. V. 9, 153 (1945).
[8] E. M. McMillan, Phys. Rev. V. 68, 143 (1945).
[8a] H. C. Pollock, Phys. Rev. V. 69, Nos. 3 and 4, 125 (1946).

A still further alternative method of accelerating particles is the wave guide accelerator or linear accelerator. Radar work during the war greatly advanced the art of radio circuitry and electronics at very high frequencies. From this work has come a very much fuller understanding of the conduction of electric waves through hol.ow guides, as well as the development of tubes for the production of microwave radio energy at high power levels. These two advances provide the basic elements of a linear accelerator.

In one form this device may employ a hollow tube energized by a very high frequency oscillator. Since even the very high power levels available are insufficient for continuous operation, the radio frequency power is supplied on a pulse cycle. Electrons are injected into one end of this wave guide so as to stay in phase with the phase velocity in the guide and are accelerated thereby to high energies. To adjust the phase velocity in the guide to the increasing velocity of the particle during acceleration, the accelerating tube is generally built as a series of tuned cavities. The electric constants of these cavities permit a satisfactory choice of traveling phase velocity so that electrons or heavy particles may be injected and successfully accelerated as they traverse the succession of cavities on their straight path down the axis of the wave guide.

The principle wave guide accelerators sprung up almost simultaneously in a great many laboratories at the end of the war as a rather obvious application of radar technique. Although quite a number of linear accelerators are now being explored in this country, work has not gone far enough to permit a real evaluation of the advantages or disadvantages of the method. E. J. Lawton and W. C. Hahn have under construction in the Research Laboratory in Schenectady a linear accelerator which we expect may provide 4½ mev electrons for a wave guide length of about 5 feet. This accelerator operates at 3000 megacycles and is just now yielding initial experimental results.

In the betatron, energy is abstracted most conveniently by means of X-rays. When the electrons in the circular orbit are disturbed by an auxiliary magnetic field, they may be caused to take a spiral path of very small pitch and strike a solid target, generally tungsten wire. X-rays are generated at this point and they pass through the walls of the tube in a beam which is considerably collimated and remain so because of forward scattering. At 100 mev, for example, the width of this beam to half energy is only 2 degrees. Because the pitch of the spiral is ordinarily very small, it has been difficult to get the electron beam out of the betatron. However, the principle by means of which this may be accomplished is quite clear and presents no insurmountable difficulties. The linear accelerator, on the other hand, may be a more convenient way of getting the electron beam out of the device. Much more experimental work will have to be done to evaluate the importance of these features of accelerators.

Nuclear Investigations with the Betatron

The radiation from the betatron which is most convenient to use is the X-radiation or γ radiation produced when the stream of electrons strikes a target placed in the tube. Matter placed in the beam of this radiation reacts in a variety of ways, the details of which are the subject of cloud chamber and ionization chamber studies.

The photo-fission of various heavy elements has been investigated by Dr. G. S. Klaiber and Dr. G. C. Baldwin.[9] Using a double, balanced ionization chamber which permitted the detection of the fission process in the presence of a strong background of ionization, he investigated uranium, thorium, bismuth, lead, thallium, gold, tungsten, and samarium. Of these elements only uranium and thorium showed measurable fission. The curve of fission yield as a function of maximum radiation energy rises sharply to a peak and falls off at higher energies. The maximum of the photo-fission curve of U lies at 18 mev and 20 mev for Th. If fission exists for other elements of this list the yield is smaller than U and Th by a factor of 10^3.

Dr. G. C. Baldwin[9] and Dr. G. S. Klaiber have been studying the multiple nuclear disintegrations induced by 100 mev γ rays from the betatron. With the 20 mev radiation which has previously been available (from cyclotrons) for laboratory use, no more than one or two nucleons are ejected from the nucleus. In Klaiber's and Baldwin's experiments a great many particles have been observed to come from the nucleus at one time. This is a reasonable result, in agreement with the qualitative concept of the nucleus which pictures it as being raised to a high temperature by the incident radiation, boiling off nucleons until a stable temperature is restored. The evaporating particles include neutrons, protons and alphas. Indicating the neutron by n, proton by p, and the alpha particle by α, the following groups have been observed to be ejected: n, p, 2n, 2p, pn, 2pn, 3pn, 2p3n (or αn) and 2pαn (or 2p α 2 n). The result is observed by measurement with a Geiger counter of the half life of the products induced in the irradiated element. Cloud chamber photos occasionally show a disintegration in the gas in the chamber which produces a "star" or multiple disintegration also. Some of these photographs confirm the multiple disintegrations deduced from ionization chamber studies. Some of these photographs present more complex phenomena which pose as yet unsolved riddles. The cloud chamber has serious limitations as a measurement device however so that the solution of some of these phenomena requires the development of new study methods.

Some observations[9] of new particles called mesons (or mesotrons) have been observed in cloud chambers in the 100 mev beam by Dr. M. Schein[10], A. J. Hartzler and Dr. G. S. Klaiber. These particles which have been observed previously as rare events in cloud chamber studies of cosmic radiation, have a mass intermediate between electrons and protons, generally believed to be around 200 electron masses (200 m_e). Cloud chamber photos in the 100 mev beam show particles which by their curvature in the magnetic field and the density of the ionization track appear to be of intermediate mass. The masses lie generally below 200 m_e and above 30 m_e. Because of the qualitative character of the cloud chamber observations a careful study of these events will have to be made by more refined methods. Where mesons fit into the nuclear picture is not clear at present; that they are part of the nuclear jig saw puzzle is certain, however, and their further study is a necessary objective for a full understanding of the nucleus.

New knowledge of the nucleus will come from this use of high energy radiation in blasting open the inner confines of the core of the atom. By observing the results of the blasting the nature of the binding forces which determine its behavior may be discovered.

---

[9] Reported at 270th Meeting of the Am. Phys. Soc. at Columbia University, New York, N. Y., January 26, 1946.

[10] University of Chicago, consultant to G. E.

Investigations Related to Atomic Power Generation

Since the publication of the Smyth report, and previously, there has been a great deal of public and private speculation concerning the possibilities of uranium piles for the generation of power. A great many combinations of active material of various degrees of enrichment, moderator, and heat transfer and shielding elements, have been suggested. In the absence of a great mass of detailed information on the nuclear and other physical properties of some of these pile materials, very few of the proposed types of piles can be ruled out completely.

Although a good deal of nuclear information, as yet not declassified, has accumulated as a result of atomic bomb work, it is certain that much more will be required before practical, and especially before economical, piles will be built. The nature of this problem is, in some respects, similar to that of the development of other new types of prime movers; for example, the mercury boiler-turbine system. There are a great many liquids which might be used in a boiler and a turbine or reciprocating engine as alternatives to water. Many of these liquids could certainly be made to function in the production of net output horsepower. The history of the development of the mercury cycle, however, has shown that beyond the basic choice of a suitable liquid from a heat cycle standpoint, is a long and arduous research task concerned with a host of physical and chemical problems, any one of which might present a serious obstacle to the practical use of the system.

In the case of the mercury cycle, for example, it was found that the solution of iron in mercury was a far more serious difficulty than was anticipated in the early stages of the development. The solubility of iron in mercury is extremely small, but under the conditions existing in a mercury boiler eventually led to the failure of the tube walls. Similarly, the problem of wetting iron with mercury developed some distressing complications which, for a time threatened the whole development. Both of these problems were solved by some very brilliant investigations by E. L. Thearle and A. J. Nerad, with the result that mercury may be made to wet iron without appreciably dissolving it.

The solutions of these and many other problems have now eliminated all of the fundamental difficulties of the mercury system, with the result that such systems may now be engineered with confidence in its long term performance.

A realistic point of view of power pile development must recognize the fact that much detailed knowledge analogous to the solubility of iron and mercury must be obtained about materials of construction of piles. These materials operate in an intense neutron "atmosphere" and there is very little information on the life and properties of materials under these conditions. Methods of testing must be developed and a body of information must accumulate as the work progresses.

This does not need to interfere at all with the development of ideas on types of piles, and their experimental testing. This exploratory work and the accumulation of materials data should go along in parallel, however.

The prime tool of a designer of power piles is an experimental pile. With this pile may be determined many of the nuclear constants; for example, the neutron absorption cross-section and possibly even some life data on properties of materials. Presumably information of this kind may be accumulating in some of the laboratories of the Manhattan Engineering District at the present time. The recent action of General Groves in setting up an experimental power pile project at the Clinton Laboratories at Oak Ridge, with industry observers and participation, is a first and very desirable step in this program and a much more accurate idea of the scope of the power pile development problem will come about from this work.

For some purposes, a very substantial amount of exploratory study may be made of possible applications of piles with only elementary knowledge of their properties. For example, in some cases heat transfer considerations will be the chief limitation on the dimensions of the active volume of a pile and may comprise the most important specification in a given prospective application.

Research and development scientists and engineers who are privileged to work on this problem have a fascinating opportunity which seldom has been matched in the history of technical developments. Their great enthusiasm for the work and their confidence in its ultimate usefulness to mankind are sufficient reasons for optimism concerning the final success of atomic power plant development.

Utility Industry's Interest in Small Industries

(*Continued from page* 192)

proach to our sales of new uses of electricity which include dielectric heating, radio frequency heating, infrared heating and many others.

Many of you are doing this work and doing the job splendidly at the same time. However, we must set our sights high, encourage our industrial sales organizations, and expand them to the point where they will be able to render adequate service and have available the time necessary for the analysis of their customers' manufacturing methods and processes. New business initially obtained may seem small in proportion to the size of the industrial sales organization necessary to do this job properly. Work with our smaller customers will pay good dividends as the ultimate growth of many of them will contribute handsomely to all phases of our business.

Just think back to those five companies we discussed. At their start, what did they amount to as customers—a total of 19 employees with a few hundreds of dollars a year electric revenue at the most. These companies had many trials and troubles at the start but with some assistance from many sources, including their utility company, they managed to create success stories that read like Horatio Alger.

You have many small industries in your territories today that could duplicate these performances within the next ten, fifteen, or twenty years. They need your help and you can give it through intelligent sales management and hard work on the part of your sales organizations.

Allen Heads P.U.A.A.

CHARLES J. ALLEN of Waterbury, Conn., vice-president of The Connecticut Light and Power Company, was elected President of the Public Utilities Advertising Association at the national convention of the organization held June 10 and 11 in Atlantic City, N. J.

Mr. Allen succeeds E. Norwood Pope of Raleigh, N. C., as president of the association, which is composed of advertising and public relations executives of electric, gas, and transportation companies in the United States and Canada.

Some Engineering and Political Aspects of Atomic Energy

By Harry A. Winne
Vice-President, General Electric Company

Address before the Annual Meeting of the Edison Electric Institute, New York, N. Y., June 3, 1946

THE atomic bombs demonstrated without question that the scientists were right in their claims that there is plenty of energy locked up in the atom and that, under certain conditions, some of this energy can be released.

Dr. Kingdon's paper explains some of the basic scientific facts underlying the release of atomic energy, and I feel sure must have convinced you that there is a great deal of research and engineering development still to be done to bring about the effective utilization of this energy for industrial or other purposes.

Many schemes which might possibly be employed in converting atomic energy to useful work have been devised, and I think I can best illustrate the problems involved by describing a few of these.

Proposed Atomic Power Systems

The energy released by fission of uranium 235 or plutonium appears almost instantly as sensible heat energy in the active material. The engineer's problem is broadly to devise heat or thermodynamic systems and engines to transform this heat into mechanical or electrical power. In many respects this, of course, is a familiar problem. One may expect the use of many well-known devices, such as heat exchangers, turbines, and heat transfer fluids for conveying heat from one mechanism to another. However, conditions associated with the nuclear reaction introduce new factors which place certain definite limitations on the system and its components.

An important requirement affecting the choice of heat system is the necessity of shielding power plant personnel and equipment from all neutron and gamma ray radiation. Such shields may be 5 ft or more in thickness, including a considerable amount of heavy material such as iron or lead. The heat transfer fluid passing through the "pile" will become more or less radioactive. Therefore, all pipes, pumps, and equipment carrying the primary heat transfer fluid will require shielding for gamma radiation. If intermediate heat exchangers are used transferring heat to a secondary fluid, it may be possible to eliminate shielding on the secondary system. Gamma radiation shielding will be of some heavy material, perhaps 5 in. of lead.

Six Proposed Power Systems

Figure 1 shows diagrammatically six systems which illustrate some of the large number of variations which one can conceive. All except the last one use a heat transfer fluid to transform heat into mechanical power at the blades of a turbine. There are other heat engines besides the turbine which might be practical on some special application, but it seems likely that vapor or gas turbines will be used in the first installation.

System A uses a liquid to transfer the heat from the "pile" or nuclear reactor to a heat exchanger in a closed cycle. The heat exchanger might then generate steam for use in a standard turbine-generator set. This system would not require gamma radiation shielding beyond the heat exchanger. System A seems favorable for an early practical solution.

System B is identical to System A except that the liquid is evaporated in the pile and the vapor condensed in the heat exchanger before return to the pile. This permits circulating less liquid as the latent heat from evaporation is utilized. The boiling may introduce problems in the control of the neutron flux. However, it may be possible to find a fluid in which the effect on neutron density is approximately the same for vapor as for liquid, in which case the system has some advantages.

System C shows evaporation of the liquid to a vapor which is used directly in the turbine instead of in an intermediate heat exchanger. This might permit a higher temperature in the turbine and higher efficiency, but it would require that the turbine be shielded.

System D contemplates the use of a gas which transfers heat directly from a pile to a gas turbine. A closed cycle is shown, which requires a large compressor developing perhaps twice as much power as the useful power taken from the shaft of the turbine. As mentioned in the Smyth report, suitable gases with low neutron absorption, such as helium, exist. To produce appreciable amounts of power, the low thermal capacity of the gas will require either extremely large flow, high temperature, or high pressure. If machine sizes are to be kept small, all three factors should be increased within the limitation of existing material.

Atomic Pile in Boilers

System E has been suggested as a means of using atomic energy in a nearly standard steam boiler and turbine equipment. The pile is placed inside of the boiler and transfers heat to it by radiation. Such a system has several major disadvantages, and may well prove impossible. To achieve reasonable size, the pile would have to operate at extremely high temperature, perhaps incandescent. The problems of material, construction and instrumentation of an incandescent pile are obviously formidable. The water in the boiler, turbine, condenser, feed system, etc., would be radioactive requiring shielding of the entire system. This would be expensive and make maintenance and control difficult.

System F is included to indicate that there is always open the possibility of new invention. This system shows diagrammatically the changing of heat energy directly into electrical energy. No practical solution of this type exists now. On the other hand, one should never artificially limit the horizon in the search for such an attractive objective.

In comparing the efficiency of these cycles with the conventional steam power plant, it is interesting to note that stack losses, as such, do not exist, but heat is

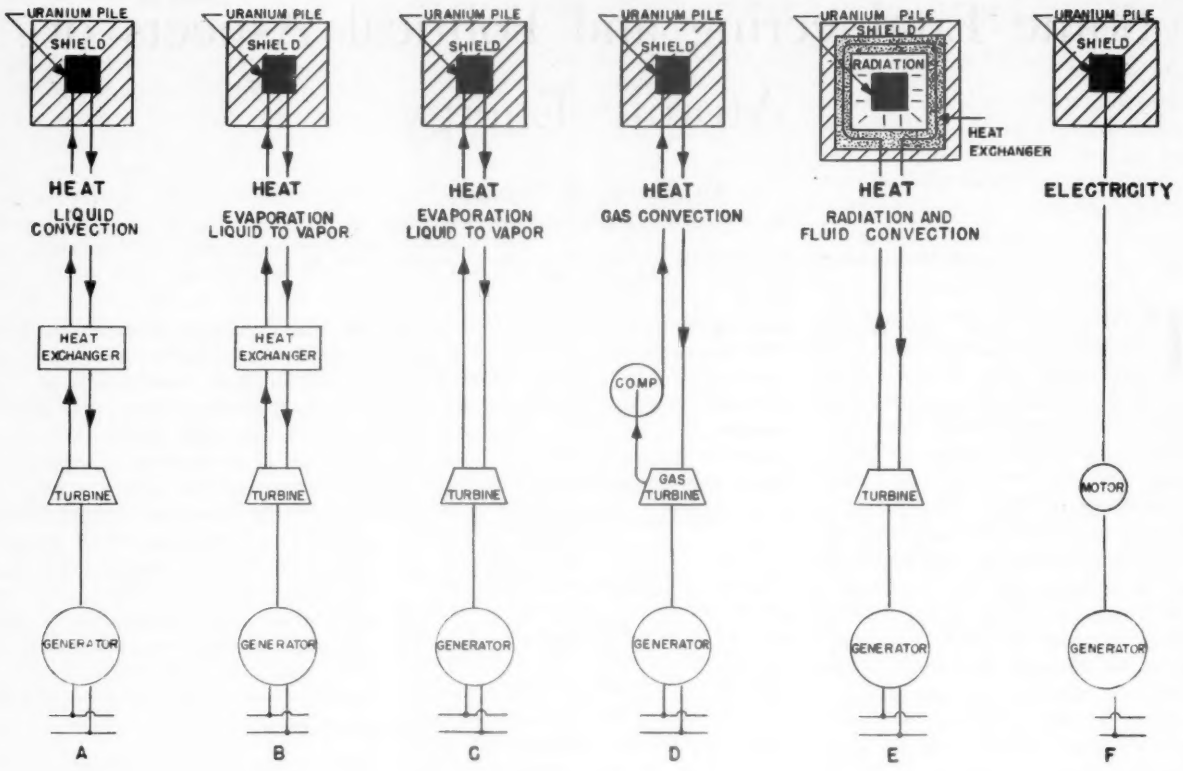


Fig. 1

still rejected in a condenser, in vapor cycle.

Many other systems can be conceived. These few examples will serve to show you that much research and development are required before it can be determined which is the best cycle to use.

Engineering Problems

An associated paper by Dr. Kingdon has discussed many of the research problems to be solved. There are also significant engineering problems. To illustrate both kinds, it is convenient to select one of the possible atomic power systems. Many of the engineering problems of System A are common to the others. This system is shown in more detail in Figure 2.

Control

The control of the rate of power generation by the nuclear reaction was discussed by Dr. Kingdon. There is no engineering reason why this control can not be integrated with the control of power flow at other critical points in the system. Such an integration will permit the power level of an entire system to be increased or decreased in response to some one requirement. This requirement might be a setting by a manual operator or an automatic adjustment to vary with the demands of the load.

Such controls will obviously require a considerable amount of instrumentation to measure various quantities. For example, temperatures, fluid flows, electric power, neutron density, gamma radiation, leaks, etc., will be measured. The integration of these various measurements must be considered both for normal varying operations and for emergency shutdown. For emergency shutdown, separate safety control rods may be used in the pile. The use of "pop off" valves on primary fluid systems will be unwise because of the release of radioactive poison. This does not appear to be a severe limitation.

Heat Transfer

The nuclear physicists have posed to the engineers a challenging problem in heat transfer. The power density in a chain reacting pile can obviously vary from the low density used at Hanford to the tremendous density of the atomic bomb. Therefore, power density is determined not by the rate at which energy can be generated but by the rate it can be taken away by heat transfer. Many of the materials used in a pile may be expensive due to extreme scarcity, or required high chemical purity. This is ample incentive for the engineer to extract the heat in a minimum volume. A considerable amount of development work is needed on many phases of heat transfer, such as:

1. Development of suitable fluids including liquid metal alloys and gases. Transmutations within the heat transfer fluid may change its properties during operation. In addition to the normal criteria for good performance, low neutron absorption must be maintained throughout all additions of alloys and transmutations of basic fluid alloys and impurities.

2. Materials permitting the use of high temperatures and high fluid velocity. Appreciable erosion cannot be permitted as replacement of parts within

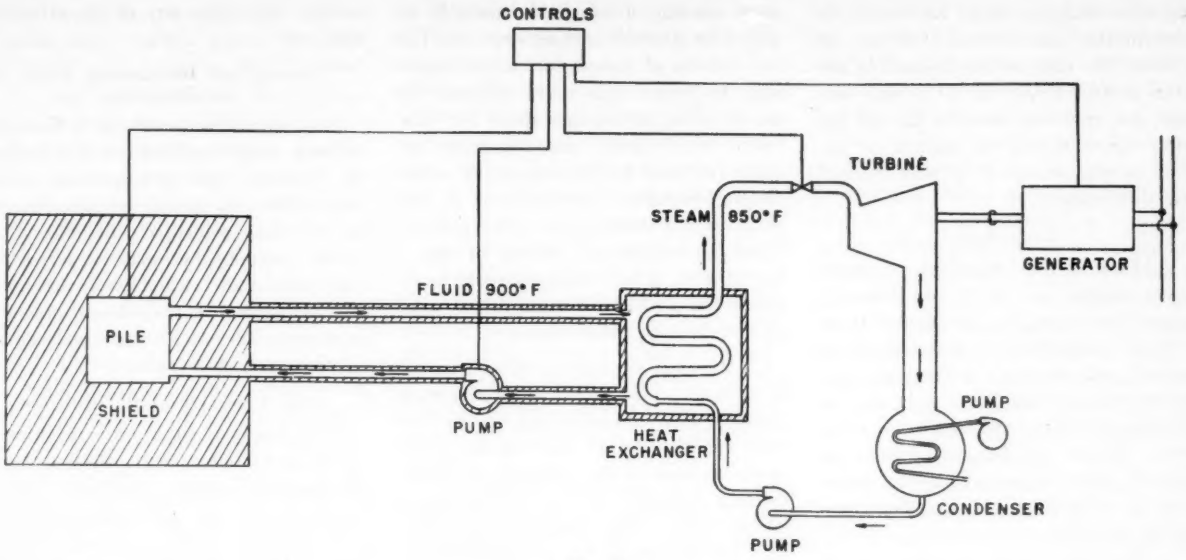


Fig. 2

a pile is extremely difficult. Inspection for weak spots prior to actual failure may be almost impossible.

3. Corrosion, scale and contamination of fluids. In addition to the usual problems of chemical corrosion, transmutations in the fluid and in the pipes may greatly complicate the solution. Such transmutations are progressive, continuing to increase throughout the life of the pile. As noted in Dr. Kingdon's paper, "Radiation Stability" of materials may affect every physical or chemical property.

4. Physical arrangement of heat transfer surfaces. In order to conserve critical and expensive materials, it will be important to arrange the heat transfer surfaces for maximum area of contact, maximum flow and minimum volume in the pile This must be accomplished without seriously compromising an efficient lattice. The fluid probably must be isolated from the uranium by barriers to prevent picking up uranium.

Structural Engineering

Many significant problems can be listed under a general heading. The mechanical design of all elements of such a pile including active material, moderators, fluid channels, control rods, instruments, etc., must all be accomplished taking account of the problems peculiar to this job such as poisoning, radiation stability, absolute prevention of leaks, shielding, and, of course, high temperatures, temperature gradients and temperature changes. Finally, the degree of reliability required is about as extreme as one can imagine. Provision may be made to salvage and reclaim used active material or ash and replace the ash with new fuel. The handling of any component in a pile once the chain reaction has maintained a high level for an appreciable time can only be done by remote control through heavy shielding.

Economics of Atomic Fuels

Some of the factors which are rather apt to be overlooked, but which must be taken into account in any attempt to study the economics of atomic fuels, are the following:

1. *Cost of enriched atomic fuel.* It is, of course, possible to establish a chain reaction using natural uranium with its 0.7 per cent of U 235, as described in the Smyth report for the Hanford piles. These piles are very large. On account of size, if for no other reason, it is likely that fuels enriched with additional U 235 or Pu 239 will be used for industrial, marine or other piles primarily to develop power. The materials used in atomic bombs are the extreme example of enriched fuel. While the amount of enrichment economical or desirable in a power pile may be much smaller than in an explosive, cost of manufacturing such enriched fuels is certain to be considerable.

2. *Denatured fuel.* As disclosed in the report of The Secretary of State's Committee on Atomic Energy, it may be in the interest of the world security to denature fuels supplied for industrial and other uses. Such a process may also contribute appreciably to the cost of the fuel.

3. *Reclamation of critical materials.* Inasmuch as the total world resources of uranium and thorium may be distinctly limited, it will probably be necessary to conserve them by reclaiming U 238 and other critical materials from the ash. This cost is chargeable to the continued use of atomic fuel for power.

4. *Investment in fuel.* It should always be realized that no chain reacting pile can be built without enough fissionable material such as U 235 to exceed the critical size required. As noted in the Smyth report, from 1 to 100 kilograms of U 235 or equivalent was expected necessary for the highly enriched atomic bomb. There is no reason to assume that less U 235 will be able to maintain a chain reaction in an enriched power pile. Thus the initial fuel required in one power plant may cost in the order of millions rather than thousands of dollars, becoming really more of a capital cost than an operating cost.

Analysis of Economics at Present Impossible

It is evidently impossible to make an accurate analysis of the economics of atomic fuel on the basis of information generally available today. The atomic energy released, if a pound of fissionable material is completely consumed, is about equivalent to that from the combustion of 1500 tons of coal. On this basis, if we assume efficiency of use, fixed charges

and other items are equal for both fuels, then the fuel cost for coal at $4 per ton is about the same as for fissionable material at $6,000 per lb. It is only surmise, but it would seem as though this latter figure should be reached or bettered in the course of lengthy research and development.

Limitations

Many of the limitations of atomic power plants have been mentioned as part of the engineering problems. However, it is important to recognize three distinct and seemingly permanent limitations which control not only the design but the field of application of atomic power plants. While engineering and research often reduce or modify limitations, it is hard to conceive that these can be eliminated.

1. *Shielding.* Many advances may be made leading to the ideal arrangement of the best materials for shielding neutron and gamma radiation. Nevertheless, these shields will probably continue to be both large and heavy.

2. *Cost of fuel.* The considerable magnitude of investment for the initial charge combined with the considerable cost of refueling, handling and reclaiming critical materials from the ash is a limitation which may greatly affect the application.

3. *Health hazards.* The Smyth report has indicated that complete success was achieved in protecting the health of personnel in the government laboratories and operations. This problem can unquestionably be handled, but it will require continuous vigilance, adequate instrumentation, and will influence the design and application of such power plants.

Applications for Nuclear Power Plants

One should expect nuclear energy power plants to be applied first where some distinct benefit results from the two unique characteristics, which are:

1. Extremely long life of the fuel.
2. Extremely small volume of the fuel compared to others of equal total available energy.

With these two unique properties in mind, it is possible to list a number of applications in the approximate order of their likely achievement.

1. *Navy and Merchant Marine ships.* The range of an atomic powered ship on one fuel charge may be of the order of a million miles. This can easily be calculated assuming a reasonable minimum amount of fissionable material required to maintain a chain reaction. The low volume of atomic fuel makes it possible to obtain this range without the use of even the normal space for shipboard fuel storage and eliminates entirely the need for the support of a continuing merchant operation or a task force with a supply train of oil tankers. Since the weight and volume of fuel is not critical, it may be economical to increase the power and speed of any class of merchant or naval vessel.

2. *Mining or other activities in remote parts of the world.* It is extremely difficult and uneconomical to develop many of the world's mineral and other resources due to the difficulty of transporting ordinary fuel or electric power to the spot. The atomic power plant may provide means for economically exploiting these resources.

3. *Emergency power plants.* Emergency power plants may find use in areas of flood or earthquake disasters, and for military operations. Mobile conventional power plants have been constructed for such purposes. However, they require continuous supplies of fuel which may seriously limit their utility. Whether or not it will be possible or practical to reduce atomic power plants to a size transportable by railroad is problematical. This might be considered in the future, but emergency power plants transported on ships are a definite possibility.

4. *Public utilities.* The use of atomic power plants for public utilities will depend primarily on economic and national policy factors. The economics were discussed previously with the conclusion that it was not possible to make any factual prediction now. Widespread use of atomic power will also depend on the world's resources of suitable atomic fuel. Estimates of these resources are not available. Neither national nor international policy regarding conservation of these resources has been established. All that can be said now is to note that the active development of atomic power certainly seems warranted for some of the preceding applications. Experience in these fields, surveys of the economic resources, and establishment of security and conservation policy will give the answer in the future.

5. *Railroads, aircraft, etc.* It appears that the shielding limitation and, to a lesser extent, the investment and maintenance limitations discussed previously put railroad and aircraft applications further away than any of the preceding ones.

National and International Policy Considerations

This discussion would not be complete without some consideration of the effect of National and International policy with respect to atomic energy. Because of the unprecedented importance of atomic weapons, we may expect a certain amount of National control in the field, and I feel that we should hope and work for sufficient International control to prevent atomic warfare.

Army Control Unjustly Criticized

The National situation is at present pretty largely in control of the Army's Manhattan Engineer District, because Congress has not yet adopted legislation to bring it under civilian jurisdiction. May I state here parenthetically that I feel the Manhattan District has been subjected to a great deal of unjust criticism. It has had no alternative but to consider the whole project primarily from the military and national security viewpoint, unless and until our government adopts a different policy. However, the District is now initiating projects pointed toward the development of peacetime applications. One of these is the power pile at Clinton Laboratories, Oak Ridge. In the design and construction of this unit, representatives of a number of interested industries will participate, so that the knowledge gained will be disseminated.

The so-called "McMahon Bill" on atomic energy is now before the Senate. If this bill, as now written, becomes law, there will be set up an "Atomic Energy Commission" of five civilian members appointed by the President.

The Commission is directed to promote research and development by private and public institutions, and also to carry on such activities in its own facilities.

It will own all facilities for the production of fissionable materials, except research units producing very small quantities.

The Commission will be the exclusive owner of all fissionable materials, but may distribute such material for research and development purposes. Through licensing requirements, it will control the sale or transfer of so-called source materials, specifically uranium and thorium, or ores containing them in specified minimum concentrations.

The Commission may conduct re-

search in military applications, and in addition may produce atomic bombs if specifically authorized by the President.

An important provision affecting possible industrial or commercia. uses is the following. While research and development in this specific field are freely permitted, no one may use commercially, or manufacture equipment for using, fissionable material or atomic energy without a license from the Commission. Furthermore, before any such use can be licensed, the Commission is directed to report to the President "whenever in its opinion any industrial, commercial, or other non-military use of fissionable material or atomic energy has been sufficiently developed to be of practical value." The President then transmits the report to Congress. Ninety days later, unless meanwhile prohibited by law, the Commission may issue licenses.

"Legislating Against Progress" Questioned

The report of the Committee which prepared the bill states that one reason for the above clause is "that the sudden introduction of certain devices utilizing the power released by nuclear fission might precipitate profound economic disorganization. Great industrial installations, representing nation-wide investments, employing many thousands of workers, might be rendered obsolete."

It seems to me this fear is much more imaginary than real, and, even if it were real, I question the advisability of suggesting that we may legislate against progress. The fear is imaginary because the development and widespread use of any new source of power is going to take a long time and occur very gradually.

Of course, this bill is not yet law, and the legislation finally adopted may differ from that described in the foregoing.

Then, of course, we should not forget the International situation. Our President, together with the Prime Ministers of Britain and Canada, has recommended that the United Nations set up a commission which, among other duties, should make proposals "for control of atomic energy to the extent necessary to insure its use only for peaceful purposes."*

Such a commission has been set up, and, as you know, Mr. Bernard M. Baruch is the United States member. At the time this is written there has been no statement as to what form of International control our Government will advocate.

The "Report on the International Control of Atomic Energy"** was issued by the State Department with emphasis on the fact that it is made "public not as a statement of policy but solely as a basis for . . . discussion."

This Report was prepared by a Board of Consultants, of which I happened to be a member, which was set up for the purpose by a Committee headed by Under Secretary of State Dean Acheson.

The results of the study made by this Board, and the plan of control it recommends, are given very briefly in the following.

The Board concludes that simple agreements or treaties between nations to forego using atomic weapons will not give adequate security. It also believes that if nations are permitted to develop and exploit atomic energy freely, restrained from producing atomic weapons only by agreement, no International inspection agency can hope to detect deliberate violations of this agreement.

So the Board proposes a program of International cooperative development, under the leadership and control of an International Atomic Development Authority.

Since uranium is the only available *natural* material which can maintain a chain reaction, if the Authority has real control of this and its products, it should be able to prevent the surreptitious manufacture of bombs. Consequently, in order to get this real control, the Authority would have dominion over deposits of uranium, would operate mines and refineries, and would operate plants in which fissionable material is produced. These are so-called dangerous activities, because if left in national hands, material for bomb manufacture might be diverted secretly.

The Authority would also own and operate research and development facilities, and would prospect for new ore deposits.

Fissionable Material May Be Leased

It would own all fissionable material, but would lease to nations or individuals such material in quantities too small, or so diluted or denatured as to be unsuitable for bomb manufacture.

"Safe" activities, open to nations under a minimum of licensing restriction, would be: nuclear research, using small non-dangerous quantities of material; the broad field of manufacture of radioactive materials, under the same conditions; the development and operation of large atomic power plants employing diluted or "denatured" material.

Now the power industry will be especially interested in the fact that, if this or a similar plan is adopted, large blocks of power *may* be produced, and for economic reasons should be, as by-product from the "dangerous" plants operated by the Authority to produce fissionable material for use in secondary power plants operated nationally. With the plan in full operation, the amount of power produced by the Authority would be of the same order of magnitude as that produced in national plants.

In order to provide national safeguards, the Authority's plants should be strategically distributed geographically, so that no one nation bent on atomic armament could seize a majority of the "dangerous" production facilities.

It is very obvious that putting such a plan into operation and making it effective poses some tremendous problems. If adopted, it may have some effects on our electric power industry which are not especially appealing to us. But, against this, we must balance the probable effect of an atomic armament race upon our whole way of life, even upon our form of government. When we consider this soberly, I think we shall agree that we can afford to pay a great deal for some form of International control which will effectively prevent such an eventuality.

Conclusion

Well, where does all this rambling discussion leave us?

It seems to me it leaves us at the very beginning of a long and expensive road of research, development, engineering and construction. It is a road which will have many turnings and forkings which we cannot now foresee. We hope and believe that as we go along this road and explore some of its forks, we shall make discoveries which will bring real benefits to humanity. It is a road along which travel will probably be regulated to some degree by legislation, perhaps by a kind of legislation new to the world, international legislation. But so long as the purpose of such regulation is to prevent the destruction of this and all other roads in a world cataclysm, we should not quarrel with it.

American industry has never hesitated to start along such a road in the past, and I am sure it will not hesitate now.

*Agreed Declaration on Atomic Energy, issued November 15, 1945.

**A Report on the International Control of Atomic Energy, Department of State Publication #2498.

PERSONALS

OSCAR H. FOGG, chairman of the Executive Committee of Consolidated Edison Company of New York, Inc., retired May 31 in accordance with the Company's age limit. He resigned that post, which he had held since 1942, and it has been abolished by the Company. He will continue as a trustee of Consolidated Edison Company. He has been a member of the Board of Trustees since 1934.

Mr. Fogg had a long and distinguished career in the public utility industry. He entered the gas business with the United Gas Improvement Company in Philadelphia, where he was born. In 1899 he became a cadet engineer, stationed at a plant of that company in Yonkers. In 1901 he became superintendent of the Newtown and Flushing Gas Company, which subsequently became a part of the Consolidated Gas—now Consolidated Edison—system. In 1904 he joined the Consolidated Gas Company and served in various research and engineering jobs.

During World War I he entered the Army and was engaged in the designing of plants for repair and maintenance of ordnance material in France, and also in recruiting and in organizing and training enlisted and commissioned personnel. He was placed in command of the Construction and Maintenance Divisions of the Ordnance Department, A.E.F., with the rank of lieutenant-colonel. The French Government gave him the Ordre de l'Etoile Noire, and the United States gave him the Distinguished Service Medal.

In 1919, upon his discharge from the Army, Colonel Fogg became secretary-manager of the American Gas Association, returning to the Consolidated Gas Company in 1924 as vice president. In 1937, after mergers of several of the gas and electric companies in the System, and the change of name to Consolidated Edison Company, he was elected vice-chairman of the Board. He retained this title until he was made chairman of the Executive Committee of the Company in 1942. Mr. Fogg was also chairman of the Executive Committees of most of the companies in the Consolidated Edison System.

Mr. Fogg was president of the American Gas Association for two years, beginning in 1927. He has recently served as a member of the Mayor's New York City Post-War Industrial Committee.

WILLIAM E. WOOD, who was elected president of the Southeastern Electric Exchange at the recent meeting at Edgewater Park, Miss., became executive vice-president of the Virginia Electric & Power Co. in 1944 following the merger of Virginia Public Service Co., of which he was president, with the Richmond utility.

Back in the 1920's Mr. Wood had been associated with the Virginia properties as operating vice-president of the Virginia Railway & Power Co., which had been acquired by the Engineers Public Service Co. The name of the company was later changed to Virginia Electric & Power. He was then elected vice-president of the Engineers Public Service Co. with headquarters in New York. It was in 1941 that he was made president of Virginia Public Service.

Mr. Wood has been on many standing committees of the old National Electric Light Association and its successor, the Edison Electric Institute, and has served as president of the Southwestern Public Service Association, the Virginia Public Utilities Association and is at present president of the Public Utilities Association of the Virginias.

ROBERT P. LIVERSIDGE has been appointed superintendent of the Southwark generating station of the Philadelphia Electric Co. After assignments in Ardmore and Richmond, he served as superintendent, electric distribution, western division; superintendent, gas distribution, eastern division; acting superintendent, and, later, superintendent, Barbadoes station, and in 1943 was made superintendent, Delaware station, the position he held at the time of his new appointment.

HARRIS E. MILLER, manager of the Springfield Division of Ohio Edison Co., was elected a vice-president of the utility at a recent meeting of directors. RUFUS MOSES, Youngstown Division manager, was also elected a vice-president. Both men are directors of the utility.

Mr. Miller has been associated continuously with the electric light and power business in Springfield, his native city, since his graduation from Wittenberg College in 1915. He was first employed by the Springfield Light, Heat & Power Co., a predecessor of Ohio Edison Co., as a meter tester. Advancing in the ranks, he became general superintendent in 1925 in charge of all physical property of the company, and in 1930 he was named general manager. When the Springfield utility was merged with electric properties in the Akron and Youngstown areas in 1930 to form the present Ohio Edison Co., Mr. Miller was named manager of the Springfield Division. He has been one of the leaders in practically every major community undertaking in Springfield for the past 16 years. During the war he served as chairman of the industrial salvage committee of the WPB for Clark County (Springfield), as well as being on the executive committee of the Civilian Defense Council, and chairman of its public utilities section.

Several new appointments have been announced by Vice President P. H. Powers of West Penn Power Company. JAMES E. FIFE is transferred from the managership of the Company's Keystone Division to head up the Northern Division with headquarters in Kittanning. He will be succeeded by ROBERT G. MACDONALD, who has been Manager of the Nittany District at Bellefonte. To fill the Bellefonte vacancy, HOWARD E. HAMILL is transferred from the managership of the Brownsville District, and he will be followed by DONALD T. FAUST, who has been District Manager at Charleroi.

Placed in the Charleroi spot is RAYMOND W. HURD, going from the Elk District managership at Ridgway, and ALEXANDER R. NEWELL is transferred from the Clarion-New Bethlehem Districts to succeed Mr. Hurd. RUDOLPH G. LINDQUIST becomes the new Manager of the Clarion-New Bethlehem Districts. He has been Assistant Manager of the Company's Nittany District. To succeed Mr. Lindquist, G. EDWARD WORTMAN is promoted from a solicitorship in the Nittany District.

At the same time that the above appointments were announced, Mr. Powers also assigned CURT G. CLARK, who has been Foreman of the Substation Department at Bellefonte, as Assistant Superintendent of Lines of the Keystone Division.

Mr. Fife succeeds FRANK M. Ows-

TON, recently deceased, in the Northern Division managership. He is a graduate of Pennsylvania State College and has been with West Penn since June 1919. The new Keystone Division Manager, Robert G. MacDonald, is a University of Pittsburgh graduate and has served with the Company since February 1928.

HARRY J. BAUER has been elected president of the New York Steam Corporation. The position was formerly held by Ralph H. Tapscott, president of the parent company, Consolidated Edison Company of New York, Inc.

BRIGADIER GENERAL E. F. JEFFE, a vice-president of Consolidated Edison Company, was made a director of New York Steam. HARLAND C. FORBES, also a vice-president of Consolidated Edison, was elected vice-president of the Steam Corp.

Mr. Bauer joined the New York Steam Corporation in 1928 as engineer, Station Operating Department. He was appointed vice-president of the corporation in 1942. Mr. Bauer is a graduate of Stevens Institute of Technology. He is a vice-president and director of the Northern Valley National Bank, Tenafly, N. J.

Brigadier General Jeffe joined the Brooklyn, Edison Company in 1916 as an assistant power engineer. He became vice-president in charge of sales of the parent company in 1936.

Mr. Forbes, who has been vice-president of Consolidated Edison in charge of development and planning since 1945, joined the New York Edison Company in 1924.

R. I. SEYMOUR, Advertising and Publicity Director of the Kansas City Power & Light Company for the past 9 years, has resigned to become vice-president in charge of sales for the Electra Manufacturing Company. He will assume his new position on July 1. The Electra Company manufactures automotive electrical replacement parts for all makes of cars and has operated in Kansas City for the past 22 years. It employs 300 people and maintains sales offices in 13 cities. The plant was recently purchased from Roger Lafite by Mr. Seymour's two associates. In his new capacity Seymour becomes part owner of the business.

While associated with the Power & Light Company, Mr. Seymour served as publicity chairman of the 1945 Kansas City War Chest campaign; chairman of the Kansas Citian and Special Events committees of the Chamber of Commerce; immediate past president of the Public Utilities Advertising Association and a former treasurer of the Advertising and Sales Executives Club. He joined the Power & Light Company in 1938, after 11 years of sales and promotion work with the General Electric Company.

WILLIAM A. CONWELL has been appointed general engineer in the structural engineering and design department, Duquesne Light Co., Pittsburgh. Mr. Conwell has been identified with Duquesne Light Co. since 1937, and previously had been connected with the Pennsylvania Railroad and with Gibbs & Hill, Inc., consulting engineers.

HAROLD P. RICHMOND, formerly general superintendent of operations for the Jersey Central Power & Light Co., Asbury Park, N. J., has joined the New York office of the Allis-Chalmers Mfg. Co., Milwaukee, Wis., as central station representative, specializing in all steam and gas turbine matters. Mr. Richmond became associated with the utility operating field in the summer of 1928 when, while still a student at Worcester Polytechnic Institute, he was employed by the United Electric Light & Power Co., New York, now Consolidated Edison Co. Following graduation in 1929, he became associated with the Eastern New Jersey Power Co., predecessor to the Jersey Central Power & Light Co. During his 16 years with this utility, he obtained a broad experience in all phases of power plant transmission and distribution line operations as well as manufactured gas operations. Mr. Richmond is a member of the American Institute of Electrical Engineers.

T. R. HEIKES, former superintendent of the American Falls power plant (Idaho) of the Idaho Power Co., has been transferred to Boise, where he will be supervisor of power plant operation and maintenance. Mr. Heikes has been engaged in power plant work for 22 years. For the past six years he has been at the American Falls plant, first as assistant superintendent and for the last four years as superintendent. L. E. GARLINGHOUSE, formerly superintendent of the Swan Falls plant, succeeds Mr. Heikes at American Falls.

D. D. SMALLEY has been named engineer of electric operation of Pacific Gas and Electric Co., effective July 1. He replaces Fred R. George, who is retiring after 45 years of service with P. G. & E. and predecessor companies. G. H. HAGAR succeeds Mr. Smalley as superintendent of the Central area of the system.

A graduate in electrical engineering from the University of California in 1910, Mr. Smalley became associated in 1911 with the Merced River Co., later merged with the San Joaquin Light & Power Corp. In 1934 he became general superintendent of the San Joaquin and Midland Counties systems, and in 1944 was appointed P. G. & E. central area superintendent. As engineer of electric operation he will have general charge of the entire company system.

Retiring engineer Fred George has had a long career in electrical engineering that began in 1901 after his graduation from the University of Southern California. His first job was in the San Francisco plant of the Mutual Electric Co., later absorbed by P. G. & E. One of his important accomplishments was the central load dispatching system he evolved and set up in 1906. He has been engineer of electric operations since 1921.

F. A. KOLB has been appointed assistant general sales manager of the Cleveland Electric Illuminating Co. Mr. Kolb has been manager of commercial sales for the company since 1944. Prior to that, he was director of commercial sales for the Duquesne Light Co. in Pittsburgh. Mr. Kolb was secretary of the Electric League of Western Pennsylvania for three years and has been active on committees of the Pennsylvania Electric Association and the Edison Electric Institute.

E. FAYE PEARCE has been appointed manager of the industrial power division of the general office sales department of the Georgia Power Co., to fill the vacancy created when Edwin M. Clapp became vice-president and manager of the Columbus division. Mr. Pearce became identified with the company as power sales engineer in 1924.

L. W. BYRON and M. R. NORTON, veteran district sales supervisors of the Wisconsin Power & Light Co.'s Beloit and Fond du Lac districts, have joined the general sales department at Madison.

Mr. Byron will serve as merchandising supervisor in charge of the merchandising program for the company's entire service area. He will supervise stock

control, coordinate window and floor displays with the general sales program and conduct a continuous training program for district salesman.

Mr. Norton, who is to be dealer cooperation manager, will supervise a program of assistance to appliance dealers, electrical contractors and plumbers and will assist in coordinating the company activities with those of dealers, manufacturers and wholesalers.

MARION GRADY, a meterman with the Indianapolis Power & Light Co. for 36 years and for many of these years active in a supervisory capacity in the meter department, has recently been made meter and relay superintendent.

Three agricultural engineers, to be located at strategic points throughout the state, have been employed by the Mississippi Power & Light Co. as part of an intensive farm and rural sales program being put on this year by the company.

WILLIAM CRECINK, NEIL CRAIG and FRED PARKER, all graduates of the agricultural department of Mississippi State College who have seen service in World War II, are the engineers, who will devote their time to increasing the farm income in their territories and extending electric service to all possible farm customers.

Mr. Crecink will be stationed at Greenville, Mr. Craig at McComb and Mr. Parker at Cleveland, serving the northwestern, southern and northern divisions of the state.

Basic Ideas

(*Continued from pgae* 212)

term "radiation stability" refers to the changes produced in materials by such exposure. This is a subject which will demand a good deal of experimental study before deciding on the materials to be used in an atomic power pile.

XII. Conclusion

In the foregoing an attempt has been made to outline the fundamental physics of a uranium power pile, and to point out some of the problems requiring solution. Some of the most important of these problems are concerned with operating the pile at the higher temperatures needed for power generation. Others are connected with efficient use of the raw material, and with operation of the pile for prolonged periods without shutdown. These problems are difficult but do not seem insuperable. No mention has been made of the radioactive by-products of the pile which may find important applications in medicine, science and technology, and which may rival the power application in interest and usefulness.

CONVENTIONS AND MEETINGS

1946

JUNE

3-5 EDISON ELECTRIC INSTITUTE, Waldorf Astoria Hotel, New York, N. Y.
3-6 National District Heating Association, The Cavalier, Virginia Beach, Va.
3-6 National Fire Protection Association, Hotel Statler, Boston, Mass.
6 Accounting Division General Committee, EEI Headquarters, New York, N. Y.
12-14 Pacific Coast Electrical Association, Inc., Annual Meeting, Fairmont Hotel, San Francisco, Calif.
17-19 National Electrical Manufacturers Association, The Homestead, Hot Springs, Va.
26-28 Canadian Electrical Association, Annual Convention, Banff Springs Hotel, Banff, Alberta, Can.
27 Electric Companies Advertising Program, Copy Group, New York, N. Y.

JULY

10 Electric Companies Advertising Program, Management Group Meeting, New York, N. Y.

SEPTEMBER

5-7 Rocky Mountain Electrical League, Estes Park, Colo.
15-18 Controllers Institute of America, Commodore Hotel, New York, N. Y.
18-21 Illuminating Engineering Society, National Convention, Chateau Frontenac, Quebec, Can.
23-25 Northwestern Section, IAEI, Boise Hotel, Boise, Idaho.
25-27 Indiana Electric Association, French Lick Springs Hotel, French Lick, Ind.
30-Oct. 2 Southwestern Section, IAEI, Hotel Sacramento, Sacramento, Cal.

OCTOBER

4-5 Electrical Equipment Committee, EEI, New Ocean House, Swampscott, Mass.
7-8 Transmission and Distribution Committee, EEI, Cavalier Hotel, Virginia Beach, Va.
7-11 American Gas Association, Atlantic City, N. J.
7-11 National Safety Congress, Hotels Stevens, Congress and Palmer House, Chicago, Ill.
14-16 Southern Section, IAEI, George Vanderbilt Hotel, Asheville, N. C.
21-23 Western Section IAEI, Gibson Hotel, Cincinnati, Ohio.
27-31 National Electrical Manufacturers Association, Annual Meeting, Hotel Traymore, Atlantic City, N. J.
28-30 Eastern Section, IAEI, Mark Twain Hotel, Elmira, N. Y.

NOVEMBER

12-15 National Association of Railroad and Utilities Commissioners, New Orleans, La.

DECEMBER

2-6 The American Society of Mechanical Engineers, Hotel Pennsylvania, New York, N. Y.

1947

APRIL

March 31-April 3 Thirteenth Annual Sales Conference, EEI, Edgewater Beach Hotel, Chicago, Ill.
7-9 AGA-EEI National Accounting Conference, Hotel Statler, Buffalo, N. Y.
28-30 Engineering Committees, EEI, Edgewater Beach Hotel, Chicago, Ill.

MAY

27-29 National Association of Purchasing Agents, Chicago, Ill.

JUNE

2-5 EDISON ELECTRIC INSTITUTE, Annual Meeting, Atlantic City, N. J.

EDISON ELECTRIC INSTITUTE OFFICERS AND COMMITTEES

(Continued)

ADVISORY COMMITTEE

P. S. ARKWRIGHT ..... Georgia Power Company, Atlanta, Ga.
D. C. BARNES ..... Engineers Public Service Co., Inc., New York, N. Y.
H. J. BAUER ..... Southern California Edison Co., Ltd., Los Angeles, Calif.
S. R. BERTRON ..... Houston Lighting and Power Company, Houston, Tex.
J. B. BLACK ..... Pacific Gas and Electric Co., San Francisco, Calif.
JOHN W. CARPENTER ..... Texas Power & Light Company, Dallas, Tex.
C. M. COHN ..... Consolidated Gas Electric Light & Power Co., Baltimore, Md.
T. D. CROCKER ..... Northern States Power Co., Minneapolis, Minn.
J. E. DAVIDSON ..... Nebraska Power Company, Omaha, Neb.
SAMUEL FERGUSON ..... The Hartford Electric Light Company, Hartford, Conn.
J. F. FOGARTY ..... The North American Company, New York, N. Y.
C. E. GROESBECK ..... Electric Bond and Share Company, New York, N. Y.
H. P. LIVERSIDGE ..... Philadelphia Electric Company, Philadelphia, Pa.
B. W. LYNCH ..... San Diego Gas and Electric Company, San Diego, Calif.
P. H. McCANCE ..... Duquesne Light Company, Pittsburgh, Pa.
WILLIAM McCLELLAN ..... Union Electric Company of Missouri, St. Louis, Mo.
IRWIN L. MOORE ..... New England Power Association, Boston, Mass.
A. B. PATERSON ..... New Orleans Public Service Inc., New Orleans, La.
H. HOBART PORTER ..... American Water Works and Electric Co., Inc., New York, N. Y.
PAUL A. SCHOELLKOPF ..... Buffalo Niagara Electric Corp., Buffalo, N. Y.
GEORGE N. TIDD ..... American Gas and Electric Company, New York, N. Y.
S. B. WAY ..... Wisconsin Electric Power Company, Milwaukee, Wis.
J. R. WHITING ..... The Commonwealth & Southern Corp., New York, N. Y.
E. A. YATES ..... The Commonwealth & Southern Corp., New York, N. Y.

CHAIRMEN OF COMMITTEES (1945-1946)

Accident Prevention, D. C. STEWART ..... Niagara Hudson Power Corp., Buffalo, N. Y.
Accounting Division General, H. H. SCAFF ..... Ebasco Services, Inc., New York, N. Y.
Customer Activities, F. W. PHELPS ..... Union Electric Co. of Missouri, St. Louis, Mo.
Depreciation Accounting, A. W. HASTINGS ..... Epsco, Inc., New York, N. Y.
General Accounting, W. C. YOUNG ..... Public Service Electric & Gas Co., Newark, N. J.
Plant Accounting and Records, A. L. DAVIES ..... West Penn Power Co., Pittsburgh, Pa.
Materials and Supplies, R. S. KING ..... Union Electric Co. of Missouri, St. Louis, Mo.
Taxation, W. S. ALT ..... Union Electric Co. of Missouri, St. Louis, Mo.
Application of Accounting Principles, R. P. KAESSHAEFER ..... American Water Works and Electric Co., New York, N. Y.
Commercial Division General, GEORGE W. OUSLER ..... Duquesne Light Co., Pittsburgh, Pa.
Engineering Division General, E. S. FIELDS ..... The Cincinnati Gas & Electric Co., Cincinnati, Ohio
Electrical Equipment, H. S. FITCH ..... West Penn Power Co., Pittsburgh, Pa.
Hydraulic Power, PAUL M. LEFEVER ..... Susquehanna Electric Co., Conowingo, Md.
Meter and Service, J. A. MORRIS ..... American Gas & Electric Service Co., New York, N. Y.
Prime Movers, R. M. VAN DUZER, JR. ..... The Detroit Edison Co., Detroit, Mich.
Transmission and Distribution, L. R. GATY ..... Philadelphia Electric Co., Philadelphia, Pa.
Industrial Relations, H. K. BRECKENRIDGE ..... West Penn Power Co., Pittsburgh, Pa.
Insurance, J. H. NICKELL ..... Philadelphia Electric Co., Philadelphia, Pa.
Membership, J. F. FOGARTY ..... The North American Co., New York, N. Y.
Prize Awards, P. S. YOUNG ..... Public Service Electric & Gas Co., Newark, N. J.
Rate Research, E. N. STRAIT ..... Public Utility Engineering & Service Corp., Chicago, Ill.
Statistical, W. N. LEWIS ..... Ebasco Services Incorporated, New York, N. Y.
Codes and Standards (a Subcommittee of the Board of Directors), H. B. BRYANS
Philadelphia Electric Co., Philadelphia, Pa.

EDISON ELECTRIC INSTITUTE OFFICERS AND COMMITTEES

OFFICERS

C. W. KELLOGG, *President*.....420 Lexington Avenue, New York 17, N. Y.
J. W. PARKER, *Vice-President*.....The Detroit Edison Company, Detroit, Mich.
H. B. BRYANS, *Vice-President*.....Philadelphia Electric Company, Philadelphia, Pa.
H. S. BENNION, *Vice-President and Managing Director*....420 Lexington Avenue, N. Y. 17, N. Y.
GILBERT W. CHAPMAN, *Treasurer*.....American Water Works and Electric Co., Inc., N. Y.
MAE B. WOODS, *Secretary*.....420 Lexington Avenue, New York 17, N. Y.

BOARD OF DIRECTORS

(Terms Expiring 1945)

H. B. BRYANS.....Philadelphia Electric Company, Philadelphia, Pa.
R. E. DILLON.....Boston Edison Company, Boston, Mass.
J. G. HOLTZCLAW.....Virginia Electric & Power Company, Richmond, Va.
R. H. KNOWLTON.....The Connecticut Light & Power Company, Hartford, Conn.
FRANK MCLAUGHLIN.....Puget Sound Power & Light Co., Seattle, Wash.
W. E. MITCHELL.....Georgia Power Company, Atlanta, Ga.
W. C. MULLENDORE.....Southern California Edison Company, Ltd., Los Angeles, Calif.
W. H. SAMMIS.....Ohio Edison Company, Akron, Ohio
PHILIP SPORN.....American Gas & Electric Service Company, New York, N. Y.
L. V. SUTTON.....Carolina Power & Light Company, Raleigh, N. C.
E. S. THOMPSON.....American Water Works and Electric Company, Inc., New York, N. Y.
G. W. VAN DERZEE.....Wisconsin Electric Power Company, Milwaukee, Wis.
P. S. YOUNG.....Public Service Electric and Gas Company, Newark, N. J.

(Terms Expiring 1946)

H. C. BLACKWELL.....The Cincinnati Gas & Electric Company, Cincinnati, Ohio
W. H. BURKE.....Ebasco Services Incorporated, New York, N. Y.
WILLIAM KELLY.....Buffalo Niagara Electric Corp., Buffalo, N. Y.
FRANK KRUESI.....Middle West Service Company, Chicago, Ill.
R. E. MOODY.....Union Electric Company of Missouri, St. Louis, Mo.
J. W. PARKER.....The Detroit Edison Company, Detroit, Mich.
H. T. PRITCHARD.....Indianapolis Power and Light Company, Indianapolis, Ind.
K. M. ROBINSON.....The Washington Water Power Company, Spokane, Wash.
E. C. STONE.....Duquesne Light Company, Pittsburgh, Pa.
R. L. THOMAS.....Consolidated Gas Electric Light and Power Co., Baltimore, Md.
WILLIAM WEBSTER.....Massachusetts Utilities Associates, Boston, Mass.
A. EMORY WISHON.....Pacific Gas and Electric Company, San Francisco, Calif.
H. E. YOUNG.....Northern States Power Company, Minneapolis, Minn.

(Terms Expiring 1947)

J. M. BARRY.....Alabama Power Company, Birmingham, Ala.
W. C. BELL.....The United Illuminating Company, New Haven, Conn.
G. A. DAVIS.....Oklahoma Gas and Electric Company, Oklahoma City, Okla.
G. M. GADSBY.....Utah Power & Light Company, Salt Lake City, Utah
R. D. JENNISON.....New York State Electric & Gas Corp., Binghamton, N. Y.
F. C. KELLOGG.....Public Utility Engineering and Service Corp., Chicago, Ill.
G. L. MACGREGOR.....Dallas Power and Light Company, Dallas, Tex.
GROVER C. NEFF.....Wisconsin Power and Light Company, Madison, Wis.
CHARLES E. OAKES.....Pennsylvania Power and Light Company, Allentown, Pa.
J. H. POLHEMUS.....Portland General Electric Company, Portland, Ore.
P. H. POWERS.....West Penn Power Company, Pittsburgh, Pa.
C. C. SMITH.....Kansas City Power & Light Company, Kansas City, Mo.
FRANK M. WILKES.....Southwestern Gas and Electric Company, Shreveport, La.

(Executive Committee)

The Executive Committee consists of the following members of the Board of Directors: Messrs. W. C. Bell, H. B. Bryans, W. H. Burke, William Kelly, P. H. Powers, W. H. Sammis, E. C. Stone, P. S. Young.